TM 11-842

WAR DEPARTMENT TECHNICAL MANUAL

RADIO TRANSMITTER

(KAAR TYPE PTS-22X)

WAR DEPARTMENT • MARCH 1946

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DESTRUCTION NOTICE

WHY — To prevent enemy from using or salvaging this equipment for his benefit.

WHEN — When ordered by your commander.

HOW — 1. Smash — Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.

2. Cut — Use axes, handaxes, machetes.

3. Burn — Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

4. Explosives — Use firearms, grenades, TNT.

5. Disposal — Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

WHAT — 1. Smash — Antenna, all components, tubes, etc.

2. Cut — Connecting cables, circuit wiring, etc.

3. Burn — All technical manuals, circuit diagrams, etc.

4. Bend — Chassis and antenna.

5. Bury or scatter — All remains.

DESTROY EVERYTHING

SAFETY NOTICE

VOLTAGES AS HIGH AS 450 VOLTS ARE USED IN THE OPERATION OF THIS EQUIPMENT. THESE VOLTAGES ARE DANGEROUS TO LIFE.

DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE THE SET WITH THE HIGH-VOLTAGE SUPPLY ON.

A FEW SERVICE CHECKS MUST BE MADE INSIDE THE SET WITH THE HIGH VOLTAGE ON. KEEP ONE HAND IN YOUR POCKET WHILE MAKING HIGH-VOLTAGE MEASUREMENTS. THIS WILL PREVENT TOUCHING THE ELECTRICAL CIRCUIT WITH MORE THAN ONE PART OF THE BODY AT ONE TIME.

SERVICING, PARTS REPLACEMENT, AND UNDERCHASSIS COMPONENT PREVENTIVE MAINTENANCE SHOULD BE DONE WITH THE VEHICULAR BATTERY CIRCUIT OPEN. SHORTING THIS CIRCUIT WILL CAUSE A FLASH AND SEVERE BURNS UNLESS THE BATTERY IS DISCONNECTED.

DO NOT ADD GASOLINE TO THE VEHICLE FUEL TANK WHEN THE TRANSMITTER IS ON. TURN OFF THE RADIO TRANSMITTER AND *KEEP* IT OFF UNTIL REFUELING IS FINISHED.

RESCUE.

In case of electric shock, shut off the high voltage at once and ground the circuits. If the high voltage cannot be turned off without delay, free the victim from contact with the live conductor as promptly as possible. Avoid direct contact with either the live conductor or the victim's body. Use a dry board, dry clothing, or other nonconductor to free the victim. An ax may be used to cut the high-voltage wire. Use extreme caution to avoid the resulting electric flash.

SYMPTOMS.

a. Breathing stops abruptly in electric shock if the current passes through the breathing center at the base of the brain. If the shock has not been too severe, the breath center recovers after a while and normal breathing is resumed, provided that a sufficient supply of air has been furnished meanwhile by artificial respiration.

b. The victim is usually very white or blue. The pulse is very weak or entirely absent and unconsciousness is complete. Burns are usually present. The victim's body may become rigid or stiff in a very few minutes. This condition is due to the action of electricity and is not to be considered rigor mortis. Artificial respiration must still be given, as several such cases are reported to have recovered. The ordinary and general tests for death should never be accepted.

TREATMENT.

a. Start artificial respiration immediately. At the same time send for a medical officer, if assistance is available. Do not leave the victim unattended. Perform artificial respiration at the scene of the accident, unless the victim's or operator's life is endangered from such action. *In this case only*, remove the victim to another location, but no farther than is necessary for safety. If the new location is more than a few feet away, artificial respiration should be given while the victim is being moved. If the method of transportation prohibits the use of the Shaeffer prone pressure method, other methods of resuscitation may be used. Pressure may be exerted on the front of the victim's diaphragm, or the direct mouth-to-mouth method may be used. Artificial respiration, once started, must be continued, without loss of rhythm.

b. Lay the victim in a prone position, one arm extended directly overhead, and the other arm bent at the elbow so that the back of the hand supports the head. The face should be turned away from the bent elbow so that the nose and mouth are free for breathing.

c. Open the victim's mouth and remove any foreign bodies, such as false teeth, chewing gum, or tobacco. The mouth should remain open, with the tongue extended. Do not permit the victim to draw his tongue back into his mouth or throat.

d. If an assistant is available during resuscitation, he should loosen any tight clothing to permit free circulation of blood and to prevent restriction of breathing. He should see that the victim is kept warm, by applying blankets or other covering, or by applying hot rocks or bricks wrapped in cloth or paper to prevent injury to the victim. The assistant should also be ever watchful to see that the victim does not swallow his tongue. He should continually wipe from the victim's mouth any frothy mucus or saliva that may collect and interfere with respiration.

e. The resuscitating operator should straddle the victim's thighs, or one leg, in such manner that:

(*1*) the operator's arms and thighs will be vertical while applying pressure on the small of the victim's back;

(*2*) the operator's fingers are in a natural position on the victim's back with the little finger lying on the last rib;

(*3*) the heels of the hands rest on either side of the spine as far apart as convenient without allowing the hands to slip off the victim;

(*4*) the operator's elbows are straight and locked.

f. The resuscitation procedure is as follows:

(*1*) Exert downward pressure, not exceeding 60 pounds, for 1 second.

(*2*) Swing back, suddenly releasing pressure, and sit on the heels.

(*3*) After 2 seconds rest, swing forward again, positioning the hands exactly as before, and apply pressure for another second.

g. The forward swing, positioning of the hands, and the downward pressure should be accomplished in one continuous motion, which requires 1 second. The release and backward swing require 1 second. The addition of the 2-second rest makes a total of 4

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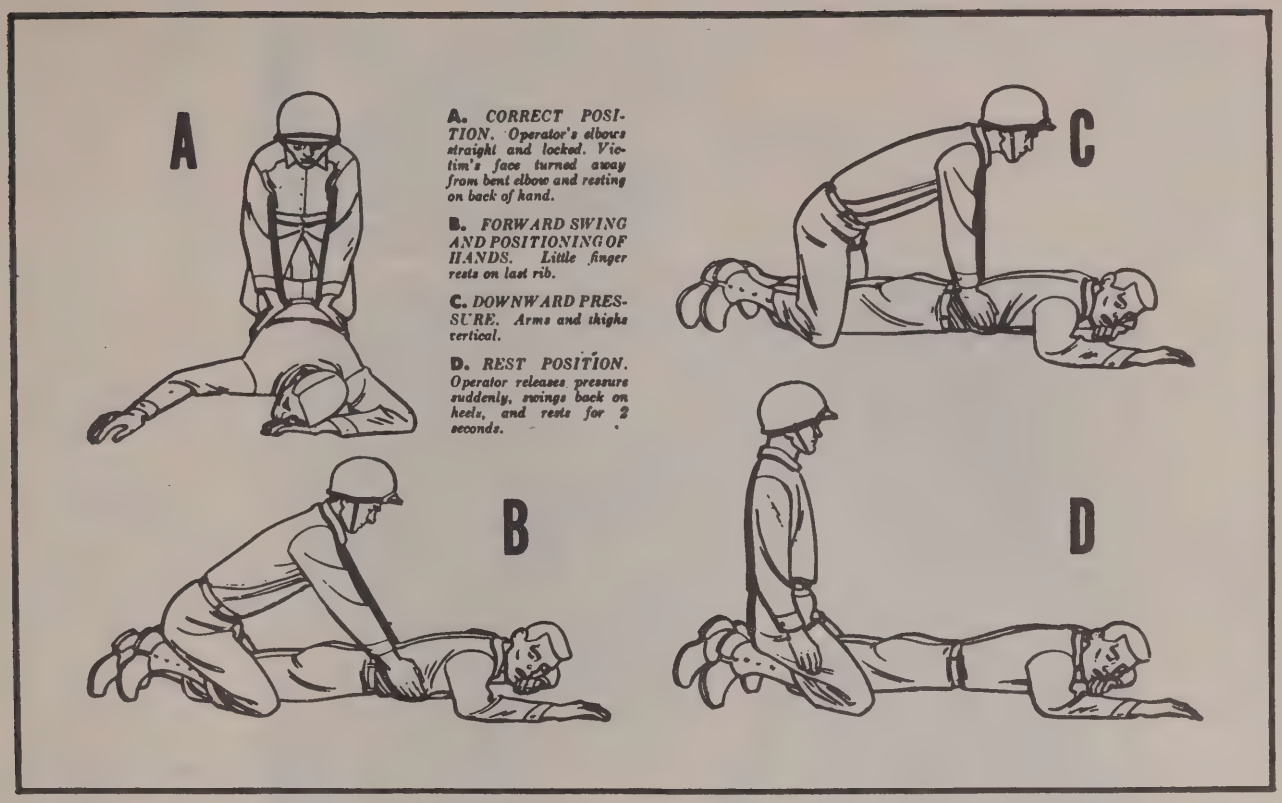
A
B
C
D
A. CORRECT POSITION. Operator's elbows straight and locked. Victim's face turned away from bent elbow and resting on back of hand.
B. FORWARD SWING AND POSITIONING OF HANDS. Little finger rests on last rib.
C. DOWNWARD PRESSURE. Arms and thighs vertical.
D. REST POSITION. Operator releases pressure suddenly, swings back on heels, and rests for 2 seconds.

seconds for a complete cycle. Until the operator is thoroughly familiar with the correct cadence of the cycle, he should count the seconds aloud, speaking distinctly and counting evenly in thousands. Example: one thousand and one, one thousand and two, etc.

h. Artificial respiration should be continued until the victim regains normal breathing or is pronounced dead by a medical officer. Since it may be necessary to continue resuscitation for several hours, relief operators should be used if available.

RELIEVING OPERATOR.

The relief operator kneels beside the operator and follows him through several complete cycles. When the relief operator is sure he has the correct rhythm, he places his hands on the operator's hands without applying pressure. This indicates that he is ready to take over. On the backward swing, the operator moves and the relief operator takes his position. The relieved operator follows through several complete cycles to be sure that the new operator has the correct rhythm. He remains alert to take over instantly if the new operator falters or hesitates on the cycle.

STIMULANTS.

a. If an inhalant stimulant is used, such as aromatic spirits of ammonia, the individual administering the stimulant should first test it himself to see how close he can hold the inhalant to his own nostril for comfortable breathing. Be sure that the inhalant is not held any closer to the victim's nostrils, and then for only 1 or 2 seconds every minute.

b. After the victim has regained consciousness, he may be given hot coffee, hot tea, or a glass of water containing ½ teaspoon of aromatic spirits of ammonia. *Do not give any liquids to an unconscious victim.*

CAUTIONS.

a. After the victim revives, keep him LYING QUIETLY. Any injury a person may have received may cause a condition of shock. Shock is present if the victim is pale and has a cold sweat, his pulse is weak and rapid, and his breathing is short and gasping.

b. Keep the victim lying flat on his back, with his head lower than the rest of his body and his hips elevated. Be sure that there is no tight clothing to restrict the free circulation of blood or hinder natural breathing. Keep him warm and quiet.

c. A resuscitated victim must be watched carefully as he may suddenly stop breathing. *Never leave a resuscitated person alone until it is CERTAIN that he is fully conscious and breathing normally.*

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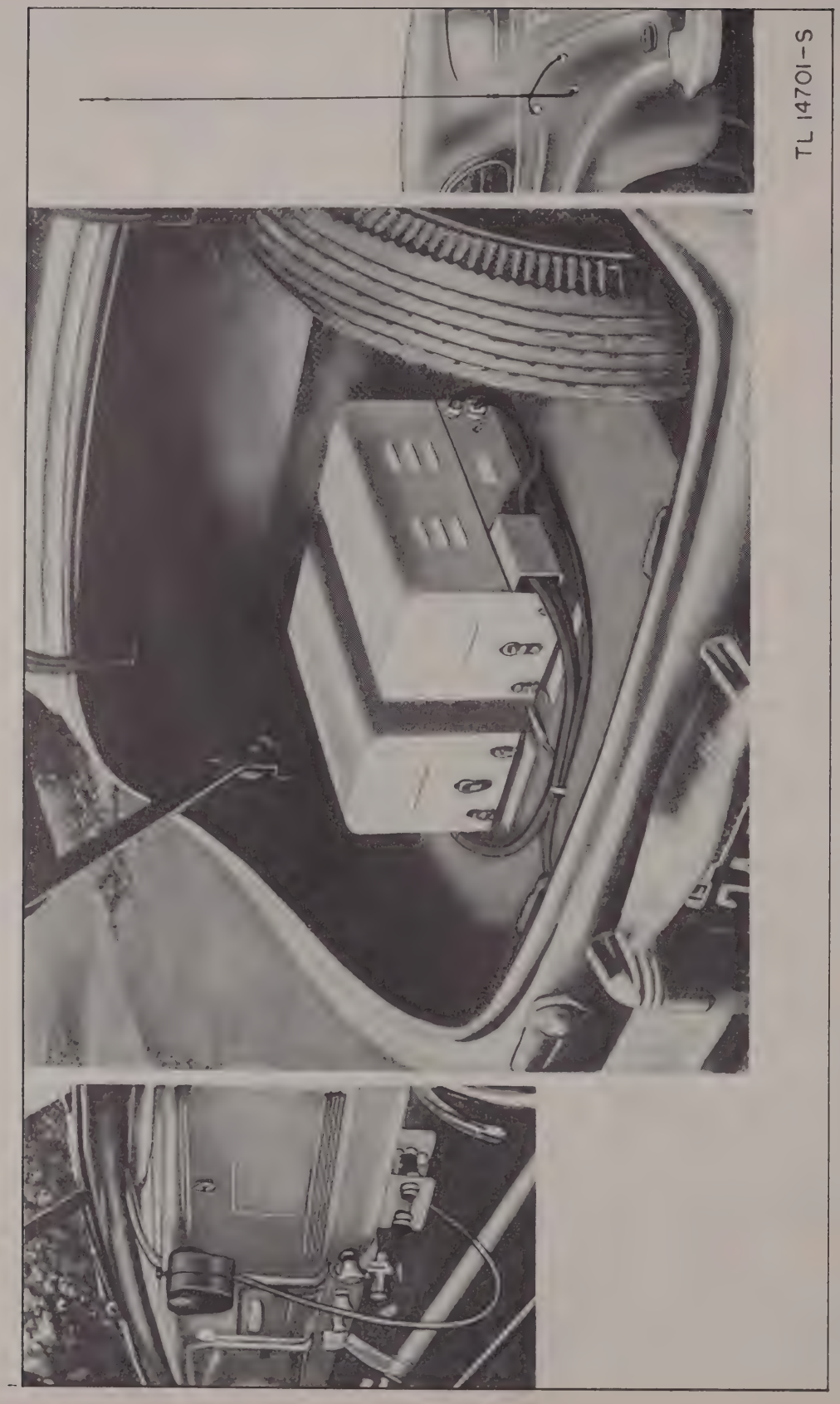


Figure 1. Frontispiece.

PART ONE

INTRODUCTION

SECTION I. DESCRIPTION

1. GENERAL.

Radio transmitter (Kaar type PTS-22X) is a five-tube, amplitude-modulated (a-m) transmitter designed and constructed for mobile service in motor vehicles. Figure 2 is a simple block diagram showing the relationship between the various components of the radio set and supplementary circuits.

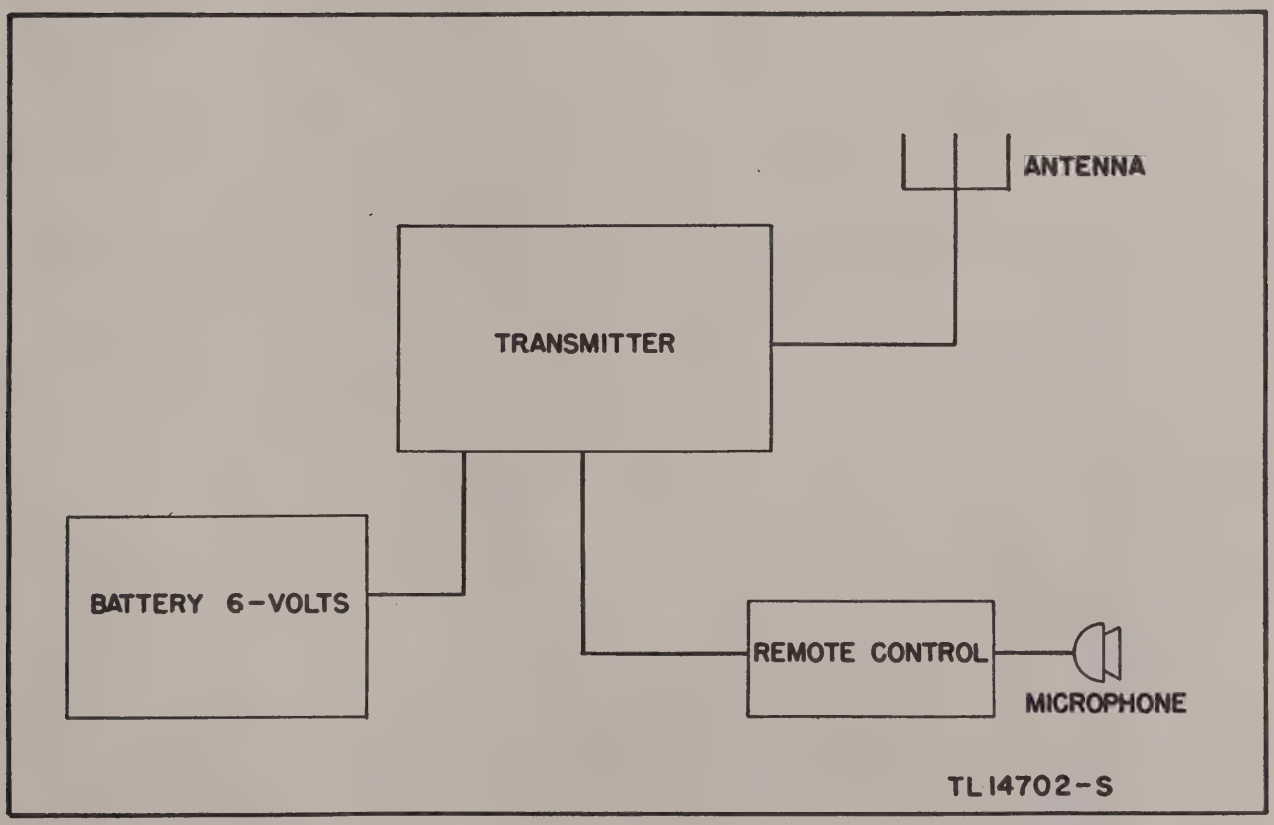


Figure 2. Transmitter PTS-22X, simplified block diagram.

2. TECHNICAL CHARACTERISTICS.

Frequency range	30.0 to 40.0 mc
Transmitter type	Crystal controlled oscillator, frequency multiplier, power amplifier
Type of signal transmitted	a-m voice
Distance range	5 mi approx
Type of modulation	amplitude
Number of tubes	5
Power input	6 volts
Stand-by	0 amp
Transmit	38 amp
Power output	22 watts
Antenna type	whip
Power source	6-volt vehicular battery
Weight	31 lbs

3. COMMUNICATION WITH OTHER RADIO SETS.

Radio transmitter (Kaar type PTS-22X) operates within the frequency range of the following sets:

Radio transmitter (Kaar type PTS-22X)	30 to 40 mc
Radio receiver (Kaar type PRS-9X)	30 to 40 mc
Radio Receiver BC-787-B	27.8 to 143 mc
Radio Set AN/GRR-2 (Hallicrafters Model SX-28-A)	550 kc to 42 mc
Radio Receiver BC-794-B	540 kc to 40 mc

4. TABLE OF COMPONENTS.

The equipment listed in the following table is necessary for operation of radio transmitter (Kaar type PTS-22X).

NOTE: Items may be packaged in a different manner from that shown, depending upon supply channels.

Component	Required No.	Height (in.)	Depth (in.)	Length (in.)	Vol. (cu ft)	Weight (lb)
Antenna and base mounting assembly	1	84	—	—	—	3
Coaxial cable ALC-22	1	—	—	48	—	1/2
Power cable PC-22	1	—	—	194	—	8-1/4
Control cable CC-22	1	—	—	172	—	1
Control unit K-TRI	1	2	2-3/8	4	0.011	1/2
Microphone 4-C with bracket	1	—	—	—	—	3/4
Transmitter PTS-22X with 1 set of tubes (includes 1 type E crystal and holder when specified)	1	9-3/16	9-7/8	18-5/8	0.96	31
Kit of running spare parts	1	13	12-1/2	12-1/2	1.18	5-3/4

NOTE: This list is for general information only. See appropriate publication for information pertaining to requisition of spare parts.

5. PACKAGING DATA.

All components of radio transmitter (Kaar type PTS-22X) are packed in a wooden case with the exception of an antenna rod which is fastened to a flat wooden board.

Component	Required No.	Length (in.)	Width (in.)	Height (in.)	Vol. (cu ft)	Weight (lb)
Transmitter and other components	1	33-1/2	13-3/4	14	3.7	70
Antenna rod (mounted on flat board)	1	87	2			3

6. DESCRIPTION OF MAJOR COMPONENTS (fig. 3).

a. Transmitter Unit. The transmitter chassis is mounted on a special shock mounted cradle. Four snap catches at the ends of the chassis hold the chassis to the cradle. A removable cover incloses the tubes, dynamotor, and crystal (fig. 6). The cover is held to the chassis by two snap catches.

b. Remote Control Unit K-TRI. The transmitter operation is controlled through a remote control unit which is installed in the driver's compartment of the vehicle. Microphone jack J9 and pilot lamp I1 are located on the front of the unit, and connector P1 for the control cable is on the rear.

c. Control Cable CC-22. The control cable is a four-conductor, rubber-covered cable 16 feet long. Each end of the cable is terminated with polarized connectors. The control cable interconnects J8 on the transmitter chassis and P1 on the remote control unit.

d. Microphone 4-C. The microphone is a single-button carbon type. The case is molded bakelite and has a built-in, push-to-talk control switch. The microphone cable is a three-conductor, rubber-covered cable 32 inches long which terminates in a 3-circuit connector plug. Included is a microphone bracket.

e. Power Cable PC-22. The power cable is a single-conductor size No. 1/0 AWG motor lead cable. The cable consists of two pieces: one 2 feet long and one 15 feet long. One end of each piece is terminated in a 150-ampere size copper lug. Two additional solderless type connecting lugs are included.

f. Coaxial Cable ALC-22. The coaxial cable is a low-impedance transmission line and is used to interconnect the transmitter and antenna. One end of the cable is terminated in connector P3. The other end has the inner conductor connected to a terminal lug, and the outer conductor (shield) has a short length of flexible copper braid attached. The over-all length of the coaxial cable is 4 feet.

g. Antenna and Base Mounting. The antenna assembly consists of two parts: an antenna rod 84 inches long and a three point support base mounting. The base mounting is designed for vertical or horizontal mounting (fig. 5). Each support rod has a conical shaped feed-through type ceramic insulator. The supports are adjustable in length and can also be bent to any desired radius. The antenna rod is inserted in the vertical tubular section of the base mounting assembly and can be adjusted and locked to the proper length. Connection to the ALC-22 coaxial cable is made through the threaded stud on the bottom feed-through insulator.

SECTION II. INSTALLATION

7. UNPACKING, UNCRATING, AND CHECKING.

Unpack the equipment carefully and inspect it for possible damage during shipment. Check all components against the list in par. 4 and the packing list included with equipment. The equipment is furnished with all tubes installed. When specified on the packing list, a crystal unit for the operating frequency or channel is installed.

8. INSTALLATION OF TRANSMITTER UNIT.

a. Preliminary Preparation. Before installing the transmitter unit in the vehicle, determine the polarity of the grounded battery terminal as follows:

(*1*) Observe which battery terminal is connected to the engine or frame. This will be the grounded terminal.

(*2*) The terminal polarity is usually marked by plus and minus signs or a red and black color code indicating positive and negative respectively. The polarity may also be indicated by the designations **POS** and **NEG** stamped in the top of the case opposite the terminals.

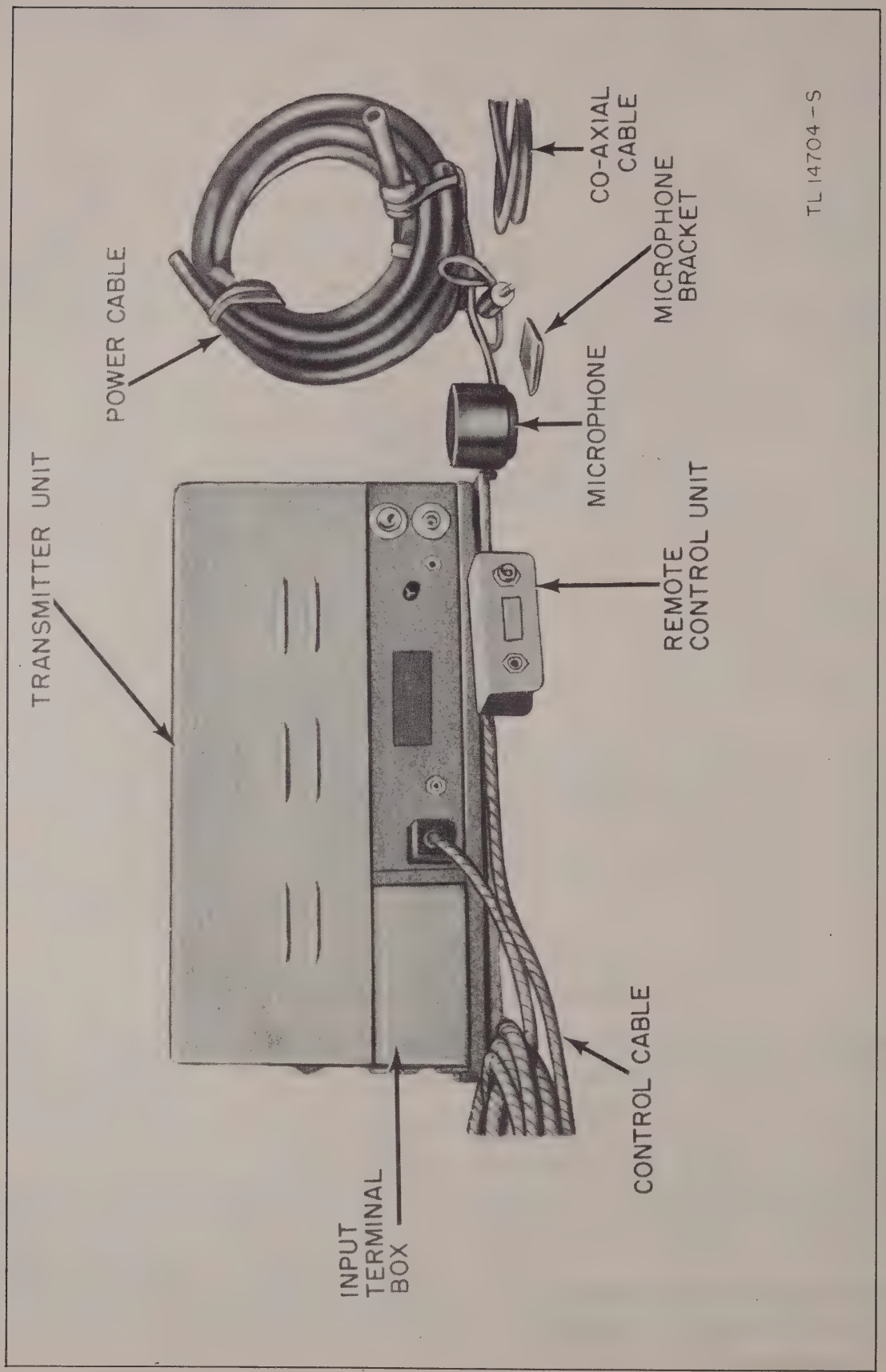


Figure 3. Transmitter PTS-22X, major components.

b. Transmitter Power Input Polarity. The transmitter is factory wired for a negative polarity grounded battery system unless otherwise indicated on the polarity tag attached to the set. Polarity of the transmitter input ground circuit must conform with the polarity of the grounded battery terminal. If the transmitter input polarity as indicated on the polarity tag agrees with the battery ground polarity, no changes in the equipment wiring will be necessary. However, if the input polarity does not agree, the transmitter input polarity must be changed. Remove the chassis from the shock mounted cradle and change the circuit wiring to conform to the required input polarity as follows:

(1) For Negative Battery Ground Input.

(*a*) **Red** coded high-voltage output lead connects to terminal on filter capacitor C20.

(*b*) **Black** coded high-voltage output lead connects to terminal on fuse holder F1.

(*c*) **Green** coded modulator bias lead connects to **black dot** terminal on the bias strip.

(2) For Positive Battery Ground Input.

(*a*) **Red** coded high-voltage output lead connects to terminal on fuse holder F1.

(*b*) **Black** coded high-voltage output lead connects to terminal on filter capacitor C20.

(*c*) **Green** coded modulator bias lead connects to **red dot** terminal on the bias strip.

CAUTION: Do not make any changes in circuit wiring.

NOTE: Provision has been made on the back side of the polarity tag under INSTALLATION RECORD to indicate the ground input polarity. Mark with a check in the space provided, the input polarity at the time of installation. This tag is a permanent record of the input polarity and will be referred to by other personnel for maintenance or re-installation of the equipment. *DO NOT REMOVE THE TAG FROM THE SET.*

c. Locating and Mounting Transmitter Unit. The recommended location for the transmitter unit in vehicles such as sedans and coupes is in the rear trunk compartment. For trucks and other types of vehicles, consideration must be given to provide accessability and also protect the equipment from moisture, dust, and dirt. In special types of installations, it may be necessary to inclose the equipment in a wate proof box. Before any drilling or actual mounting is done in the vehicle, the transmitter unit should be set in place and so arranged that maximum accessibility, together with a short direct connection to the antenna can be made. For sedans and coupes, the set should be located on the left-hand side of the trunk compartment. Two mounting holes on each end of the base plate are provided. Fasten the base plate to the floor with self-tapping metal screws or as an alternate method mount the plate on a wood board (plywood) and bolt the board to the floor. Care must be taken in drilling the mounting holes to avoid puncturing the gasoline tank or feed line.

9. INSTALLATION OF REMOTE CONTROL UNIT AND MICROPHONE BRACKET.

a. Locate the remote control unit at a convenient place along the lower edge of the instrument panel. Drill two 7/32-inch diameter holes 3-3/16 inches apart in the bottom lip of the panel and bolt the control in place.

b. Locate the microphone bracket at a position on the instrument panel which will place the microphone within easy reach of the operator. Mark the mounting hole centers and drill the holes with a 5/32-inch diameter drill. If it is inconvenient to use the nuts to hold the bracket, drill and tap the holes for a 6-32 machine screw; use a No. 35 drill. As an alternate method two binding-head type, No. 6 self-tapping screws can be used.

10. INSTALLATION OF ANTENNA.

a. Figure 5 shows in detail two ways that the antenna base mounting can be installed. In an actual installation, the support rods will have to be bent and adjusted in length to conform to the contour of the body or roof. Three 3/4-inch diameter holes will be required in the body for the mounting insulators. The antenna must be installed on the side of the vehicle body closest to the transmitter unit.

b. The antenna rod telescopes into the vertical tubular section of the base mounting assembly. An adjustable lock arrangement provides a 10-inch adjustment in antenna height. The actual height or length required is dependent upon the operating frequency. For operating frequencies betwen 30 and 35 megacycles, (mc) extend the antenna to its full length; for frequencies between 35 to 40 mc, shorten the antenna to the lowest position.

c. Securely tighten all joints and parts of the antenna assembly in order to maintain good mechanical mounting and electrical connections.

11. INTERCONNECTING COMPONENTS.

a. Connecting Transmitter Unit to Battery (fig. 7). Remove the power input terminal cover. Connect the short length of cable PC-22 to the input terminal designated **G.** The other end of the cable is connected to the frame or body of the vehicle. Use the solderless connector lug furnished and make a good electrical connection at the point of

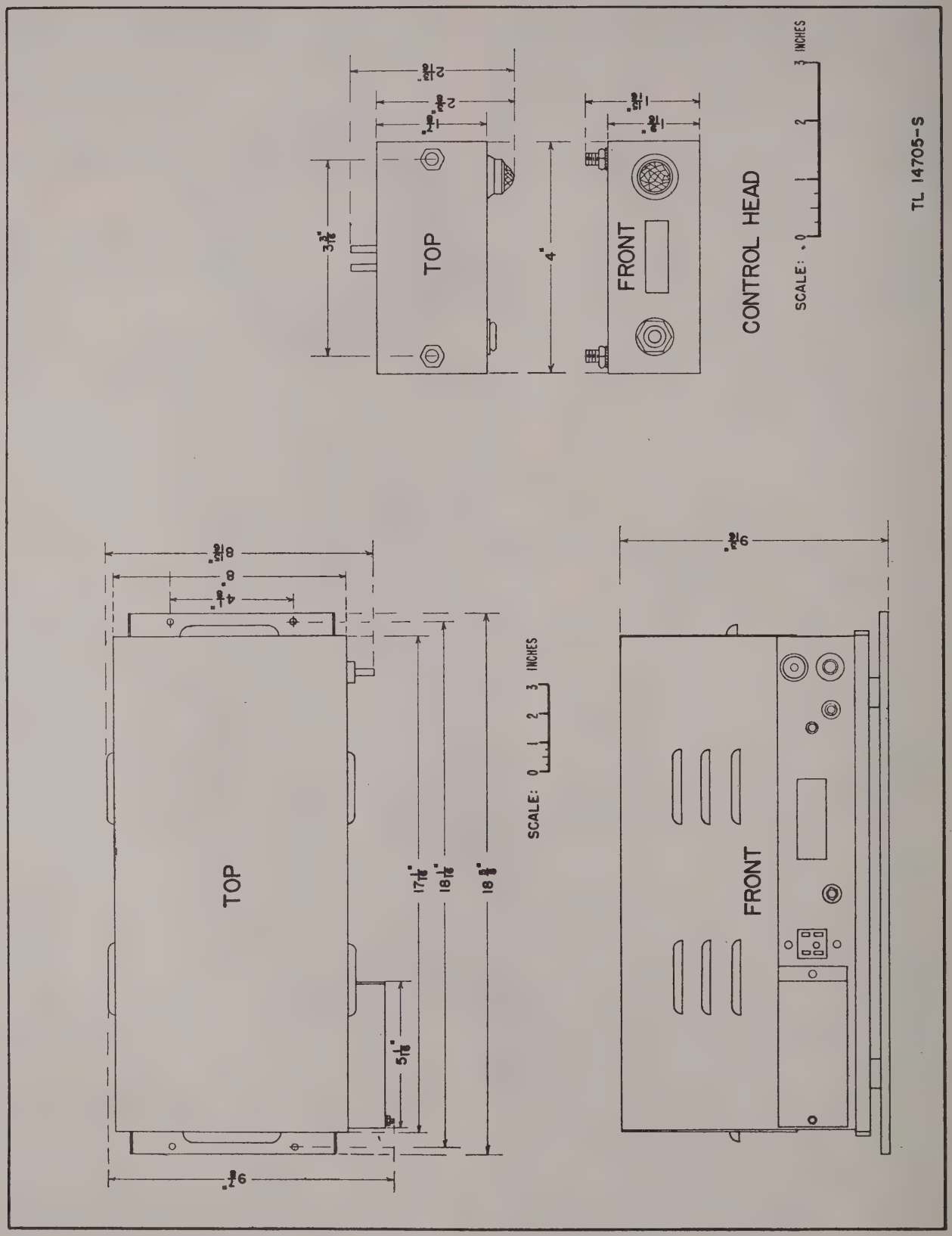


Figure 4. Transmitter PTS-22X, outline dimensional drawing.

attachment. Connect the long length of cable PC-22 to the other input terminal. Run the cable to the front of the vehicle where the cable is to be connected to the ungrounded battery terminal or the battery side of the starter switch or relay. Use only the required length of cable; cut off any excess cable and attach the solderless connector lug. Replace the power input terminal cover.

CAUTION: Always make the final connection of cable PC-22 to the battery or starter switch and not to the input terminal on the transmitter. The terminal cover must always be in place when the equipment is in service.

b. Connecting Transmitter Unit to Remote Control Unit. Run control cable CC-22 inside the vehicle along either side of the floor under the floor

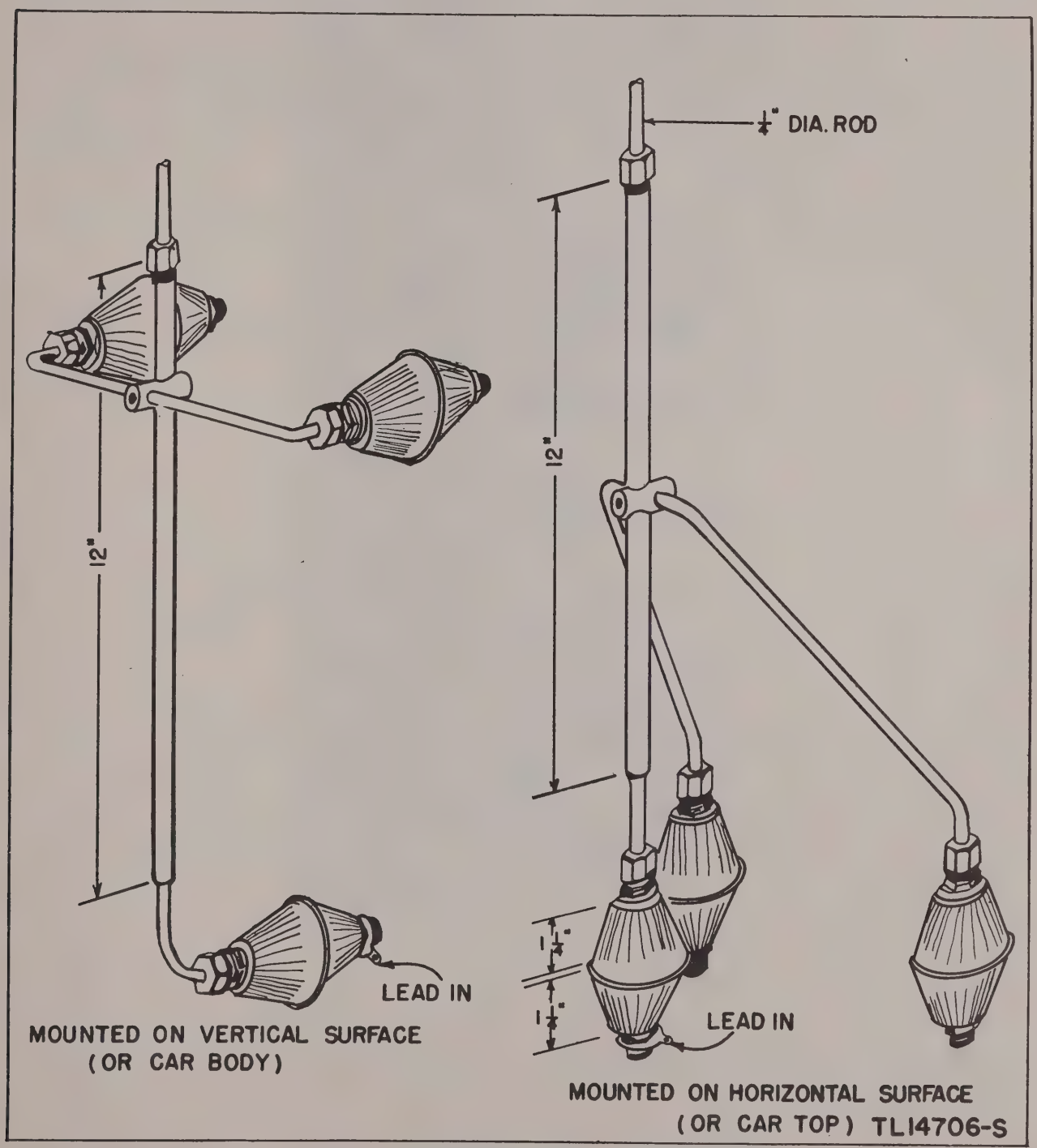


Figure 5. Transmitter PTS-22X, antenna base mounting drawing.

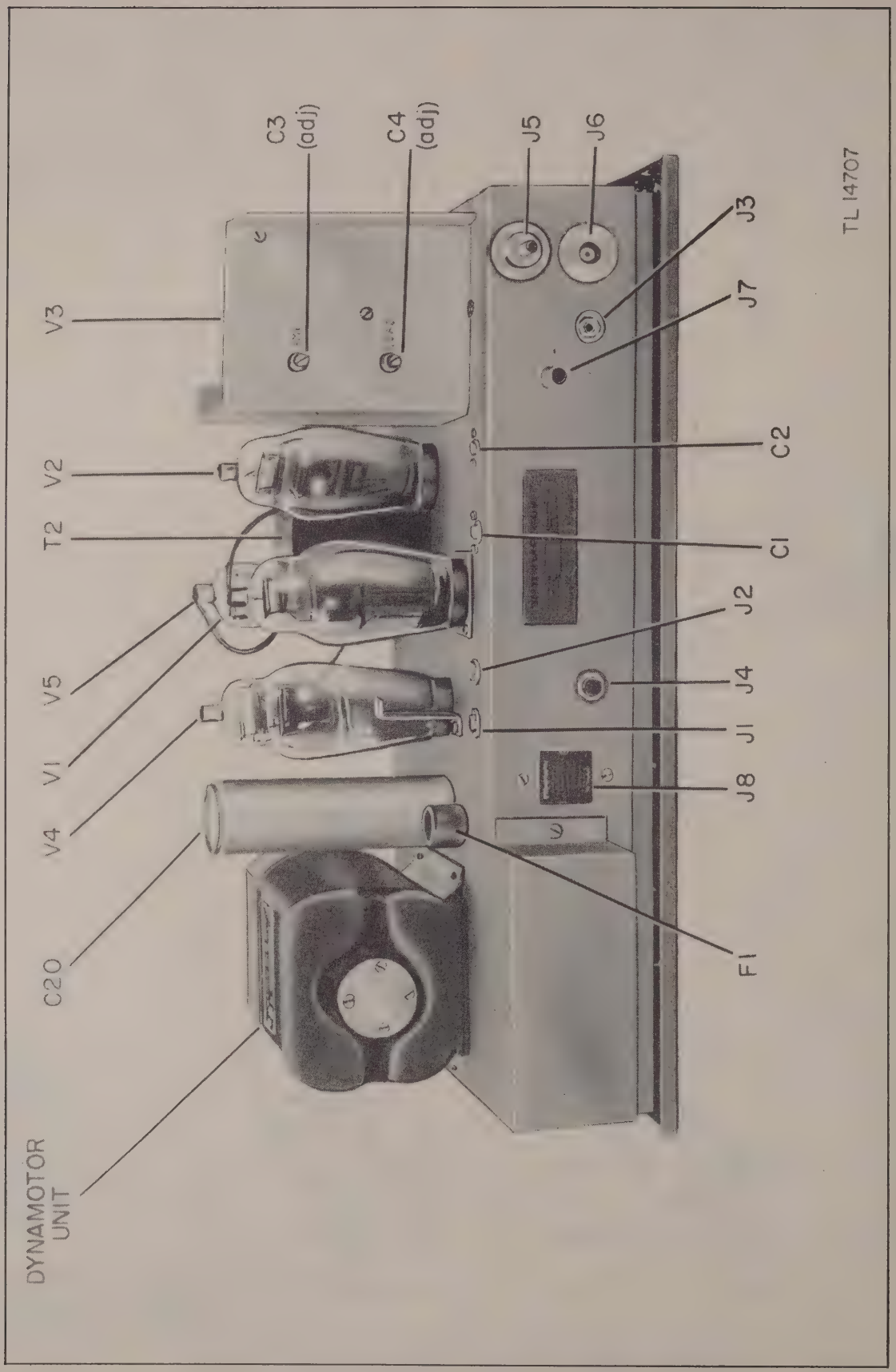


Figure 6. Transmitter PTS-22X, cover removed.

mat. Connect jack J10 to plug P1 on the remote control unit and plug P2 to jack J8 on the transmitter chassis. If the installation requires the cable to be run along the frame on the underside of the vehicle, some type of weatherproof covering or conduit must be used. In some cases it may be necessary to remove jack J10 from the cable to run the cable through holes or under some type of seats. Carefully observe the cable color code when removing and replacing J10.

c. Connecting Transmitter Unit to the Antenna. Connect the lug attached to the inner conductor of coaxial cable ALC-22 to the threaded stud on the lower antenna mounting insulator. The outer conductor (shield) of the coaxial cable has a short length of flexible braid attached. Connect this lead to the body at a point near the base of the antenna. A good electrical ground connection must be made at this point and it is recommended that a self-tapping sheet metal screw be used. Locate the hole for the grounding screw at a point beneath the fender where it will not show on the body. Connect plug P3 to jack J6 on the transmitter chassis and securely tighten the locking ring.

d. Installation Check Test. This test is found in section XIII and is covered by this section.

NOTE: Before the equipment can be used by the operating personnel, the set must be properly tuned and adjusted to the operating frequency.

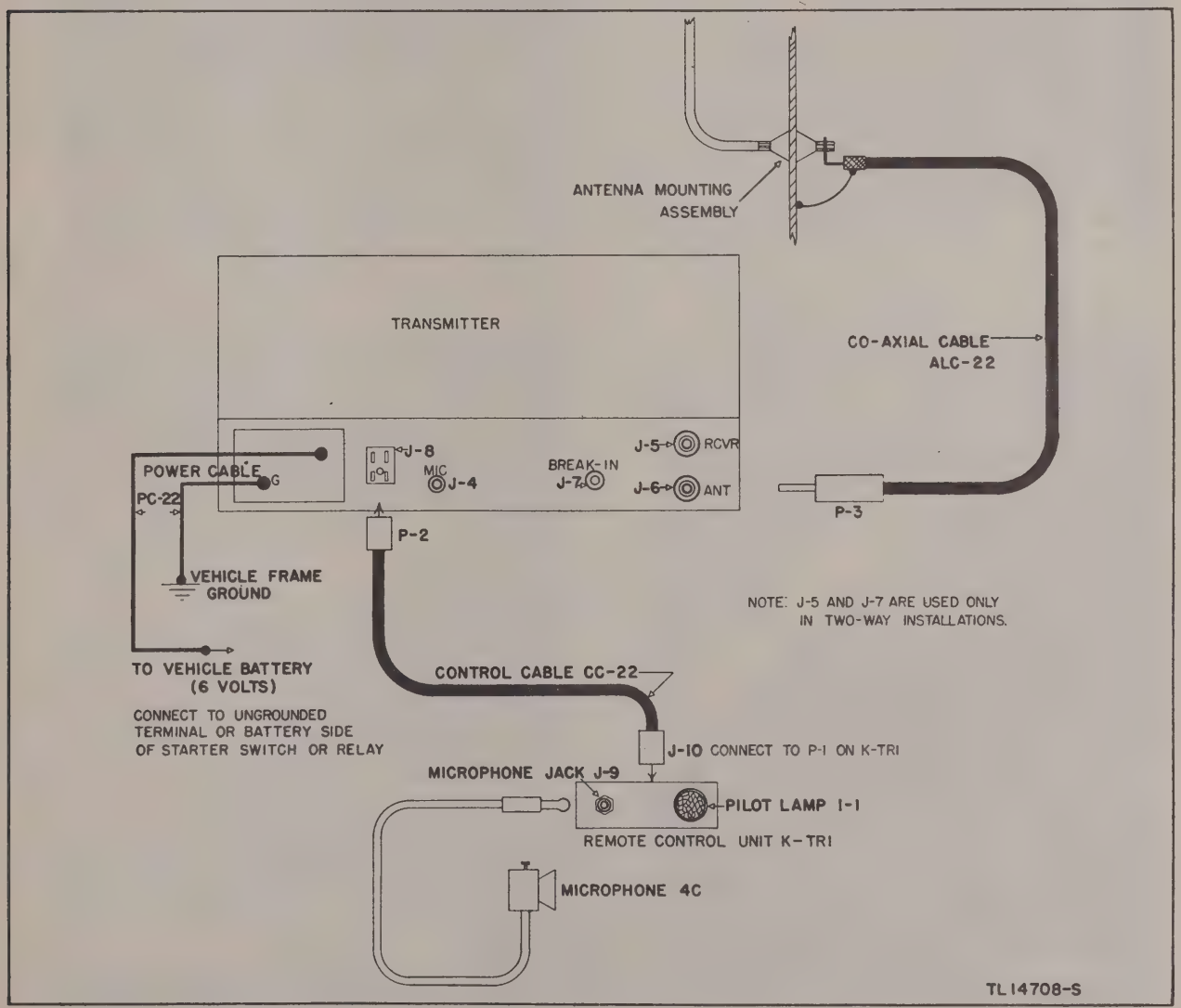


Figure 7. Transmitter PTS-22X, cording diagram.

Figure 8. Siting, good and bad locations.

PART TWO

OPERATING INSTRUCTIONS

NOTE: For information on destroying the equipment to prevent enemy use, refer to the destruction notice at the front of the manual.

SECTION III. CONTROLS AND THEIR USE

12. CONTROL CIRCUIT.

Complete control of the equipment operation is through the push-to-talk switch on the microphone. No power OFF-ON control switch is required. The microphone is plugged into jack J9 on the remote control unit. Operation of the microphone switch operates the relays in the transmitter unit and simultaneously applies the filament and plate power. Indicator lamp I1 on the remote control unit indicates transmitter ON condition. Operation of the equipment is practically instantaneous with less than 1 second required for full carrier output. Releasing the microphone switch restores the equipment to power OFF stand-by condition.

SECTION IV. OPERATION

13. OPERATING PROCEDURE.

To operate the transmitter, press the microphone switch and speak into the microphone in a normal tone of voice. Generally it is best to talk past the microphone by holding it slightly to one side rather than speaking directly into it. When the microphone switch is pressed, the indicator lamp on the remote control will light, indicating that the transmitter is operating. Releasing the button turns the set off.

14. SITING.

Best communication results when the set is operated in a high open location with no hills, high buildings, or large structures between points of communication. When possible, avoid operation under bridges, in gulleys, under high tension lines, or in dense woods. Figure 8 shows good and bad sites for operation.

SECTION V. EQUIPMENT PERFORMANCE CHECK LIST

15. PURPOSE AND USE OF CHECK LIST.

a. General. The equipment performance check list (par. 16) will help the operator determine whether the set is functioning properly. The check list gives the item to be checked, the conditions under which the item is checked, the normal indications and tolerances of correct operations, and the corrective measures the operator can take. Check item 1 before starting (before turning the equipment on), item 2 during operation, and item 3 when stopping (when turning the equipment off).

b. Action or Condition. For items 1, 2, and 3 the information given in the action or condition column represents an action that must be taken to check the normal indication given in the normal indication column.

c. Normal Indications. The normal indications listed include the visible and audible signs that the operator will perceive when he checks the items. If the indications are not normal, the operator should apply the recommended corrective measures.

d. Corrective Measures. The corrective measures listed are those the operator can make without turning the equipment in for repairs. If the set is completely inoperative or if the recommended corrective measures do not yield results, trouble shooting is necessary. However, if the tactical situation requires that communication be maintained and if the set is not completely inoperative, the operator must maintain the set in operation as long as it is possible to do so.

16. EQUIPMENT PERFORMANCE CHECK LIST.

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	1	Microphone.	Microphone plugged in jack on control unit.		
EQUIPMENT PERFORMANCE	2	Microphone.	Press microphone switch.	Indicator lamp lights.	Check pilot lamp, microphone plug.
				Dynamotor starts and runs.	Check control cable and plug connections.
			Call station (test).	Called station answers.	Check fuse, antenna assembly, and connections.
STOP	3	Microphone.	Release microphone switch.	Indicator Lamp goes out.	
				Dynamotor stops.	

PART THREE

MAINTENANCE INSTRUCTIONS

SECTION VI. PREVENTIVE MAINTENANCE TECHNIQUES

17. MEANING OF PREVENTIVE MAINTENANCE.

Preventive maintenance is a systematic series of operations performed at regular intervals on equipment, when turned off, to eliminate major break-downs, unwanted interruptions in service, and to keep equipment operating at top efficiency. To understand what is meant by preventive maintenance, it is necessary to distinguish between preventive maintenance, trouble shooting, and repair. The prime function of preventive maintenance is to *prevent* break-downs and, therefore, the need for repair. On the other hand, the prime function of trouble shooting and repair is to locate and correct *existing* defects. The importance of preventive maintenance cannot be overemphasized. A system of radio communication depends on the performance of every set. It must be *ready* to go on the air when it is needed and it *must* operate efficiently. Therefore, it is vitally important that radio operators and repairmen maintain their radio sets properly.

NOTE: The operations in section VI and VII are first and second echelon (organization operators and repairmen) maintenance. Some operations in section IX are higher echelon maintenance.

18. DESCRIPTION OF PREVENTIVE MAINTENANCE TECHNIQUES.

a. General. Most of the electrical parts used in this equipment require routine preventive maintenance. This preventive maintenance varies. Some parts require a different kind of maintenance than others. Some require more, some less. Definite and specific instruction must be followed. Hit-or-miss techniques cannot be applied. This section of the manual contains these specific instructions to guide personnel assigned to perform the six basic maintenance operations: Feel, Inspect, Tighten, Clean, Adjust, and Lubricate. Throughout this manual the lettering system for the six operations will be as follows:

F — Feel
I — Inspect
T — Tighten
C — Clean
A — Adjust*
L — Lubricate*

The first two operations show if the other four are needed. Selection of operations is based on a knowledge of field needs. For example, dust encountered on dirt roads during cross-country travel filters into equipment no matter how much care is taken to prevent it. Rapid changes in weather (such as heavy rain followed by blistering heat), excessive dampness, snow, and ice tend to cause corrosion of exposed surfaces and parts. Without frequent inspections and the necessary tightening, cleaning, and lubricating operations, equipment becomes undependable and subject to break-down when it is needed most.

b. Feel. The feel operation is used most often to check rotating machinery, such as dynamotors, blower motors, and drive motors, also to determine whether electrical connections and bushings are overheated. Feeling will show the need for lubrication or the existence of other defects requiring correction. The maintenance man *must* become familiar with the normal operating temperatures of motors, transformers, and other parts, to recognize signs of overheating.

NOTE: It is important to perform the feel operation as soon as possible after shut-down and always before any other maintenance is done.

c. Inspect. Inspection is the most important operation in preventive maintenance. A careless observer will overlook evidence of minor trouble.

*The Adjust and Lubricate operations do not apply to radio transmitter (Kaar type PTS-22X).

Although these defects may not at the moment interfere with performance of the equipment, invaluable time and effort can be saved if they are corrected *before* they lead to major and costly break-downs. To be able to recognize the signs of a defective set, make every effort to become thoroughly familiar with indications of *normal* functioning. Inspection consists of *carefully* observing all parts of the equipment, noticing their color, placement, state of cleanliness, etc. Inspect for the following conditions:

(*1*) Overheating, as indicated by discoloration, blistering, or bulging of the parts or surface of the container; leakage of insulating compounds; and oxidation of metal contact surfaces.

(*2*) Placement, by observing that all leads and cabling are in their original positions.

(*3*) Cleanliness, by carefully examining all recesses in the units for accumulation of dust, especially between connecting terminals and binding posts. Parts, connections, and joints should be free of dust, corrosion, and other foreign matter. In tropical and high-humidity areas, look for fungus growth and mildew.

(*4*) Tightness, by testing any connection or mounting which appears to be loose.

d. Tighten, Clean, and Adjust.* These operations explain themselves. Specific procedures to be followed in performing them are given wherever necessary throughout part three.

CAUTION: Screws, bolts, and nuts should not be tightened carelessly. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

Whenever a loose connection is tightened, it should be moistureproofed and fungiproofed again by applying the varnish with a small brush. See section IX for details of moistureproofing and fungiproofing.

e. Lubricate.* Lubrication refers to the application of grease or oil to the bearings of motors or rotating shafts. It may also mean the application of a light oil to door hinges or other sliding surfaces on the equipment.

19. VACUUM TUBES.

NOTE: Do not touch the tubes immediately after shutdown. Severe burns may result from contact with the envelopes of hot tubes.

a. Inspect (I).

(*1*) Inspect glass envelopes, tube caps, and tube connector clips for accumulation of dirt and corrosion. Tubes with loose plate caps or envelopes, should be replaced if possible.

(*2*) Examine the tube connector clips for corrosion and for loss of tension with resulting looseness. Check the condition of the wire leads soldered to the clips.

(*3*) Inspect the firmness of tubes in their sockets. Make the inspection by pressing the tubes down in the sockets and testing them in that position, *not* by partially withdrawing the tubes and jigging them from side to side. Movement of a tube tends to weaken the pins in the base and unnecessarily spreads the contacts in the socket. Inspect the tube sockets at the time the tubes are removed.

(*4*) Be careful when removing a tube from its socket. Never jar a warm tube. Always remove connection to the plate cap.

b. Tighten (T). Tighten the nuts that hold the sockets to the spacer bushings. Do not apply excessive pressure. Too much pressure will strip the threads. Tighten loose tube connector clips. The clip can be tightened by gently compressing it with the fingers.

c. Clean (C). Clean the tubes if necessary. Remove the dust and dirt from the glass envelope with a clean lint-free dry cloth.

20. CAPACITORS.

a. Inspect (I).

(*1*) Thoroughly inspect the case and bushing of the filter capacitor C20 for leaks. Examine the electrolytic capacitors C21 and C22 for leaks, bulges, and discoloration.

(*2*) Inspect the plates of variable capacitors for dirt, dust, or lint. Examine the movable set of plates for signs of damage or misalignment that would cause them to touch the fixed plates during tuning. Inspect the ceramic end plates of variable capacitors for cracks.

NOTE: Do not move or rotate the movable plates of the variable capacitors for inspection.

b. Tighten (T). Tighten the mounting nut on filter capacitor C20. Do not break the bushing or damage the gasket.

c. Clean (C). Remove all dust and lint between the plates of variable capacitors by blowing dry compressed air through the plates.

21. RESISTORS.

a. Inspect (I). Inspect the coating of the vitre-

*The Adjust and Lubricate operations do not apply to radio transmitter (Kaar type PTS-22X).

ous-enameled resistors for signs of cracks and chipping especially at the ends. Examine the bodies of all types of resistors for blistering, discoloration, and other indications of overheating. Inspect all connections for corrosion, looseness, and broken leads. Do not attempt to move the resistors because there is danger of breaking the connections at the point where they enter the body of the resistor. Such defects cannot be repaired.

b. Clean (C).

(*1*) Clean all carbon resistors with a small brush. The vitreous-enameled resistors must be kept clean to avoid leakage between the terminals. Wipe them with a dry cloth. However, if the dirt deposit is unusually hard to remove, use Solvent, Dry-cleaning.

(*2*) Resistors with discolored bodies cannot be cleaned. Discoloration indicates that there has been overloading and overheating at some time prior to the inspection. The discoloration is probably due to circuit trouble which requires an analysis for correction. Trouble-shooting procedures are described in part five.

22. FUSES

a. Inspect (I). Inspect the fuses for loose end caps, broken or cracked glass case. Examine the fuse element. A blown or broken fuse should be replaced.

b. Tighten (T). Tighten the bushing nut on the fuse holder. Do not break the bushing or damage the gasket.

23. INSULATORS.

a. Description. Ceramic stand-off insulators are used to support coils L2 and L4 and conical shaped feed-through ceramic insulators are used to insulate and support the antenna base mounting assembly. Radio frequency potentials are present at these points and deposits of foreign substance on the surface will reduce the insulation value. Strains and cracks may be present which will reduce the mechanical supporting strength of the insulators. Therefore, it is important that these insulators be inspected frequently.

b. Inspect (I). Inspect the physical condition of the insulators. They should be clean, without cracks or chips.

c. Tighten (T). Molded-in brass inserts are used in the stand-off insulators. The inserts are tapped for the coil mounting and insulator support screws. Tighten the screws when necessary. Avoid forcing the screws down too tight. Excess pressure may break the insert loose and crack the insulator. If the insert is loose and the insulator shows strains or cracks, replace the insulator. The nuts on the antenna feed-through insulators should be checked and tightened.

d. Clean (C). Use a clean cloth to wipe the surface of the insulator. Never use abrasive materials. If dry-cleaning solvent (SD) is used, carefully wipe and polish the surface.

24. RELAYS

Relay K2 is considered normal if the exterior is free from dirt or dust; the contacts are not burned, pitted, or corroded; the contacts are lined up and correctly spaced; the moving parts travel freely and function in a satisfactory manner; the relay assembly is securely mounted; and the field coil shows no signs of overheating. Relay K1 is totally inclosed and is not subject to preventive maintenance.

a. Inspect (I).

(*1*) Inspect the relay for defects. The contacts may be examined with the aid of a flashlight and mirror.

(*2*) Check the mechanical action of the relay to make certain that when the moving and stationary contacts come together they make positive contact and are directly in line with each other. *Do not attempt to align the contacts by bending the movable contact spring assembly.*

b. Tighten (T). Check and if necessary tighten the relay assembly mounting nuts.

c. Clean (C).

(*1*) *Relay Exterior.* Brush the exterior of the relay with a soft brush.

(*2*) *Relay Contacts.*

(*a*) When necessary to clean relay contacts, burnish with a clean blade of a burnishing tool (Tool, switchboard, contact burnisher, WECo. No. 265C, Signal Corps stock No. 6R41065C), if available. Place between the contacts of the relay and press the contacts together with slight pressure and move the blade back and forth as necessary to obtain desired results. When contacts are sufficiently dirty to require further cleaning, remove remaining dirt with dry-cleaning solvent (SD) applied with a toothpick, and clean with the flat side of a clean dry toothpick or similar material. Again burnish, using a clean blade of the burnishing tool.

(*b*) If a burnishing tool is not available, apply carbon tetrachloride with a toothpick as previously described, and clean with the flat side of a

clean dry toothpick or similar material. Dry and polish the contacts by drawing a strip of smooth, *hard finish* paper between the contacts with slight pressure applied to press them together. Soft paper which will disintegrate and leave small particles on the contact surfaces must *not* be used.

25. MULTIPLE CONNECTORS.

Multiple connectors are used on cable CC-22 to connect the transmitter to the remote control unit.

a. Inspect (I). Inspect the male and female ends of cable CC-22 for corrosion and collected dust.

b. Clean (C). Clean the male and female contacts of the connectors with a brush moistened in carbon tetrachloride. Remove corrosion with No. 0000 sandpaper, then wipe with a clean cloth.

26. CORDS AND CABLES.

The interconnecting cables are the life lines of the equipment. Condition of the cables must be closely observed. Mobile operation in all kinds of weather, driving on all kinds of roads, subjects cabling to a great deal of punishment.

a. Inspect (I). Inspect the cables for cracked or deteriorated insulation, frayed or cut insulation at the connecting and supporting points, and improper placement which places the cables or connections under strain.

b. Tighten (T). Check the connectors to see that they are properly inserted in their respective receptacles. Tighten loose cable clamps and coupling rings. Check the connections of power cable PC-22; proper operation of the equipment is dependent upon a good tight electrical contact at the terminal points. Use care in tightening the power cable input terminal connections so as not to short the wrench across the terminals or short the *hot* lead to the frame or body. Check and if necessary tighten the lug connection of coaxial cable ALC-22 to the antenna.

27. PILOT LAMPS.

The pilot lamp is used to indicate power ON operation of the transmitter and is located on the remote control unit. The pilot lamp can be readily removed and replaced.

a. Inspect (I). Inspect the pilot-lamp assembly for loose jewel or mounting bushing.

b. Tighten (T). Tighten loose jewel or mounting assembly.

28. JACKS.

The circuit metering jacks require very little attention since they are used only for periodical tune up or adjustment of the equipment. Microphone jack J9 on the remote control unit requires inspection only at infrequent intervals. Tighten the mounting nut and increase spring tension only when necessary.

29. MICROPHONE.

a. Inspect (I). Unscrew the cap inclosing the button unit and inspect the switch contacts. Check the action on the contacts to make sure they are touching properly when the switch button is pressed. Examine the switch contacts and the button unit contacts for dirt or corrosion. Unscrew the cap from the microphone plug and examine the cord connections.

b. Tighten (T). Tighten any loose connections in the microphone assembly and increase the tension of the contact springs if necessary. Check and tighten, if necessary, the microphone plug assembly.

c. Clean (C). Clean the switch and button contacts in the microphone with dry-cleaning solvent (SD) and if necessary remove corrosion with a piece of crocus cloth followed by a clean cloth. If the microphone plug is dirty or corroded, use paste metal polish Sig C stock No. 6G1516. After cleaning, remove all traces of polish with dry-cleaning solvent (SD) and finish off with a clean dry cloth.

30. CRYSTAL UNIT.

The crystal unit is not subject to preventive maintenance. DO NOT OPEN THE CRYSTAL HOLDER TO INSPECT THE CRYSTAL UNIT.

31. DYNAMOTOR.

The dynamotor used in this equipment is not subject to preventive maintenance. The bearings have been factory lubricated and sealed, and no service is required during the normal life of the unit. It may be necessary, after a long period of service (1,000 hours or more) to replace the brushes. Replacement brushes do not require fitting since they are shaped to fit the commutator. Occasionally it will be necessary to inspect the brushes to see that they are long enough to make firm contact with the commutator. See that the brush springs have adequate tension, and that the brushes are in firm contact with the commutator. Be sure the brush caps are tight. Use dry compressed air to blow out any accumulated dirt or dust. Blow the air through the end openings on the case.

32. CHASSIS AND DUST COVER.

a. Inspect (I). Inspect the outside and inside of the dust cover, chassis, and shock mount cradle, paying strict attention to every detail. Check the

snap catches to see that they securely hold the chassis to the cradle and the cover to the chassis.

b. Clean (C). Clean the cover, chassis, and cradle with a clean dry cloth and use dry compressed air to blow out all accumulations of dirt and dust. Repaint any surface found scratched, rusted, or chipped.

c. Tighten (T). Tighten all loose screws or nuts used in the assembly and mounting of the components. If necessary, tighten the tension on the snap catches.

33. STORAGE BATTERY.

The vehicle storage battery furnishes the power for operating the equipment. Optimum operation of the transmitter is dependent upon proper maintenance of the storage battery. The storage battery should always be fully charged, and the generator operation should be checked for proper charging rate. Inspect the battery regularly for correct electrolyte level and specific gravity of electolyte. Refer to TM 11-430, TB SIG 123, and TB SIG 178 for further information on maintenance of batteries.

34. ANTENNA.

a. Inspect (I). Inspect the general condition of the antenna. Check the rod (whip section) and base mounting assembly for physical damage. Check all fittings and connections for tightness. Be certain that the rod (whip section) is securely fastened in the base mounting assembly.

b. Tighten (T). Tighten securely all fittings and joints on the base mounting assembly.

c. Clean (C). Remove all dust, dirt, and foreign matter from all parts.

SECTION VII. ITEMIZED PREVENTIVE MAINTENANCE

35. INTRODUCTION.

For ease and efficiency of performance, preventive maintenance on this equipment will be broken down into operations that can be performed at different time intervals. In this section, the preventive maintenance work to be performed on the radio set at specified time intervals is broken down into units of work called items. The general techniques involved and the application of the FITCAL operations in performing preventive maintenance on individual parts are discussed in section VI. These general instructions are not repeated in this section. When performing preventive maintenance, refer to section VI if more information is required for the following items. All work is to be performed with the power removed from the equipment. After preventive maintenance has been performed on a given date, the equipment should be put into operation and checked for satisfactory performance. (See par. 16, Equipment Performance Check List).

36. PREVENTIVE MAINTENANCE TOOLS AND MATERIALS.

The following preventive maintenance tools and materials will be needed:

Common hand tools.
Clean soft rags.
Camel's-hair brush.
Paste metal polish (Signal Corps stock No. 6G1516).
No. 0000 sandpaper.
Crocus cloth.
Relay burnishing tool.
Dry-cleaning solvent (SD).
Screwdrivers (small and medium).
Set of socket wrenches (1/4 to 9/16 inch).
Allen setscrew wrench (1/8 inch across flats).

NOTE: Gasoline will not be used as a cleaning fluid for any purpose. Solvent, Dry-cleaning, is available as a cleaning fluid through established supply channels. Oil, Fuel, Diesel, may be used for cleaning purposes when dry-cleaning solvent (SD) is not at hand. Carbon tetrachloride will be used as a cleaning fluid only in the following cases: where inflammable solvents cannot be used because of the fire hazard, and for cleaning electrical contacts including relay contacts, plugs, commutators, etc.

37. ITEM 1, EXTERIOR OF TRANSMITTER UNIT.

OPERATIONS.

IC Cover, chassis, shock cradle.
IT Plugs and connectors.
IT Snap catches.

38. ITEM 2, TOP OF CHASSIS.

PRELIMINARY STEP. Remove cover.

OPERATIONS.

ITC Tubes.
I Fuse.
IC Variable capacitors.
IC Dynamotor.

39. ITEM 3, BOTTOM OF CHASSIS.

PRELIMINARY STEPS. Disconnect plugs and cables. Remove cover. Remove chassis from cradle.

OPERATIONS.

ITC Capacitors.
IC Resistors.
ITC Insulators.
ITC Relay.
IT Tube sockets.

40. ITEM 4, REMOTE CONTROL UNIT.

OPERATIONS.

IT Pilot lamp.
ITC Microphone jack.
IT Connector.

41. ITEM 5, MICROPHONE.

OPERATIONS.

ITC Microphone, cord, and plug.

42. ITEM 6, INTERCONNECTING CABLES.

OPERATIONS.

IC Cables.
ITC Connectors.

43. ITEM 7, ANTENNA.

OPERATIONS.

ITC Antenna assembly.

44. ITEM 8, BATTERY.

IC Vehicle storage battery.

45. PREVENTIVE MAINTENANCE CHECK LIST.

The following check list is a summary of the preventive maintenance operations to be performed on this equipment. The time intervals shown on the check list may be reduced at any time by the local commander. For best performance of the equipment, perform operations at least as frequently as called for in the check list. The echelon column indicates which operations are first echelon maintenance and which operations are second echelon maintenance. Operations are indicated by the letters of the word FITCAL. For example, if the letters ITCA appear in the Operations column, the item to be treated must be inspected (I), tightened (T), cleaned (C), and adjusted (A).

Item No.	Operations	Item	When performed			
			Daily	Weekly	Monthly	Echelon
1	ITC	Exterior of transmitter unit.		X		1st
2	ITC	Top of chassis.			X	2d
3	ITC	Bottom of chassis.			X	2d
4	ITC	Remote control unit.			X	2d
5	ITC	Microphone.			X	2d
6	ITC	Interconnecting cables.			X	2d
7	ITC	Antenna.	X			1st
8	ITC	Battery.		X		1st

NOTE: X indicates when operations are to be performed.

* The Adjust and Lubricate operations do not apply to radio transmitter (Kaar type PTS-22X).

F	I	T	C	A	L
Feel	Inspect	Tighten	Clean	Adjust*	Lubricate*

SECTION VIII. LUBRICATION

46. LUBRICATION.

Lubrication is not essential or required, therefore no War Department Lubrication Order is prescribed for this equipment.

SECTION IX. MOISTUREPROOFING AND FUNGIPROOFING

47. GENERAL.

a. When equipment is operated in highly humid climates, excessive failure of parts and decreased operating efficiency are usually caused by the accumulated effects of moisture, rather than by inferior parts. Rapid temperature changes accompanied by fog, rain, dew, or high humidity promote such failures.

b. The effects of moisture on resistors, capacitors, coils, chokes, transformer windings, terminal boards, and insulting strips can be recognized in the form of corrosion, low insulation resistance, flash-overs, and cross-talk. Moisture also accelerates fungus growth which increases these effects.

48. REDUCING FAILURES.

a. A moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. The treatment consists of applying a film of moisture- and fungi-resistant varnish to all susceptible parts of the equipment. This film provides a nonwetting surface. Equipments which have been treated have been marked with the letters MFP and the date of treatment. Equipment not marked should be examined, and if treatment has not been applied, the equipment should be returned to third or higher echelon maintenance units for treatment.

b. TB SIG 13 (and Changes), Moistureproofing and Fungiproofing Signal Corps Equipment, contains a detailed description of this treatment.

c. Re-treatment may be required after a period of use. Need for this re-treatment is indicated by excessive failures.

49. TREATING RADIO TRANSMITTER (KAAR TYPE PTS-22X).

Use the procedure outlined in TB SIG 13 (and Changes) to moistureproof and fungiproof radio transmitter (Kaar type PTS-22X).

50. TREATING EQUIPMENT AFTER REPAIRS.

If the coating of protective varnish has been punctured or broken during repair and if complete treatment is not needed to reseal the equipment, brush-coat the affected part. Be sure the break is completely sealed.

PART FOUR

AUXILIARY EQUIPMENT

NOT USED

PART FIVE

REPAIR INSTRUCTIONS

NOTE: Failure or unsatisfactory performance of equipment used by Army Ground Forces and Army Service Forces will be reported on W. D., A.G.O. Form No. 468 (Unsatisfactory Equipment Report); by Army Air Forces, on Army Air Forces Form No. 54 (Unsatisfactory Report).

SECTION X. THEORY OF EQUIPMENT

51. CIRCUIT BLOCK DIAGRAM.

a. A block diagram of the transmitter circuit is shown in figure 9. The quartz crystal frequency is one-sixth of the operating carrier frequency. Tube V1 functions as a crystal oscillator-doubler, the output of this stage being twice the crystal frequency. The frequency is multiplied three times by the frequency multiplier stage for a total of six times the original crystal frequency. The output of the frequency multiplier stage provides excitation to the radio-frequency (r-f) amplifier stage. The r-f amplifier stage is amplitude modulated and coupled to the 1/4 wave antenna system.

b. Amplitude modulation of the carrier is provided by the modulator stage consisting of tubes V4 and V5. The audio-frequency voltage developed by the microphone is transformer coupled to modulator tubes V4 and V5 which operate as a push-pull class AB amplifier. The audio output voltage of the modulator stage is superimposed on the direct-current (d-c) plate voltage for the r-f amplifier stage to produce amplitude modulation of the carrier.

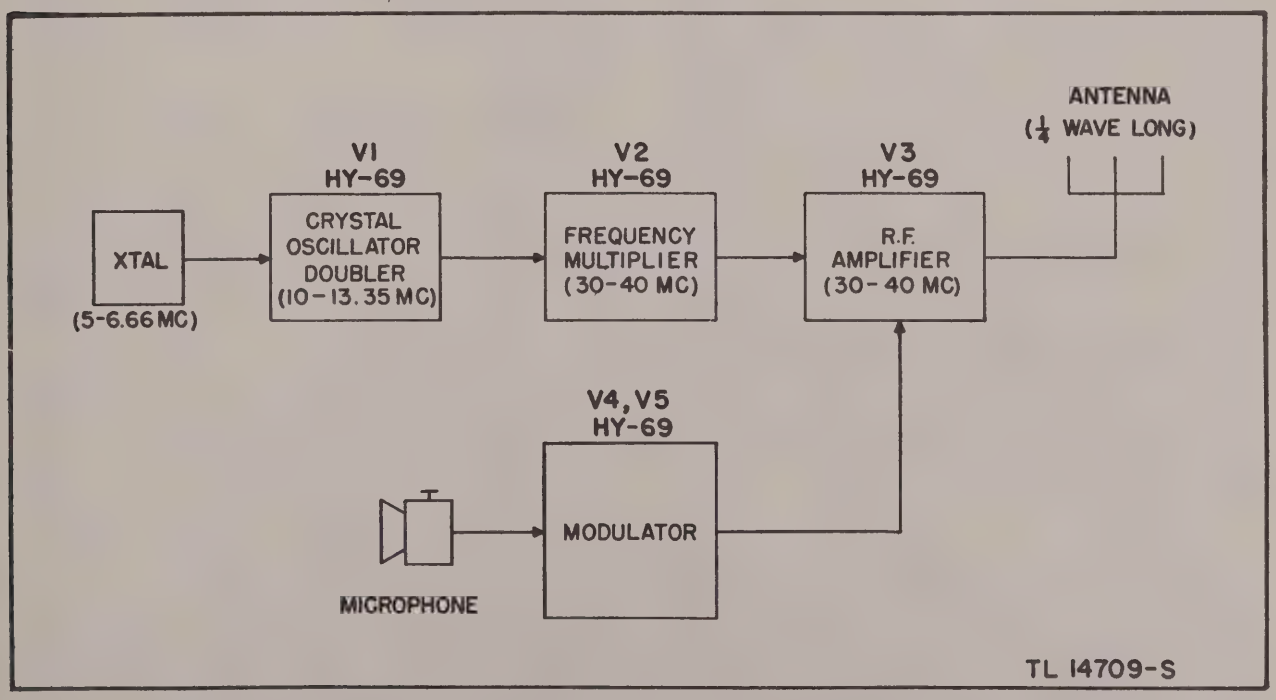


Figure 9. Transmitter PTS-22X, circuit block diagram.

52. RADIO-FREQUENCY SECTION (fig. 10).

a. Oscillator Circuit. Oscillator tube V1 functions as a combination oscillator and harmonic generator. The plate and screen grid elements of the tube are electrically connected by resistor R2 and capacitor C7 (triode connected). R2 is a screen dropping resistor which serves to keep the screen grid at a lower d-c voltage than the plate, while capacitor C7 serves to keep the plate and screen at the same r-f potential. The crystal oscillates on its fundamental frequency as an untuned Pierce oscillator. The plate tank circuit consisting of C1, C9, and L1 is resonated to the second harmonic of the crystal oscillator frequency (twice the crystal frequency), thus enabling the oscillator tube to perform its added function, that of a harmonic generator. Capacitor C9 in addition to being a part of the tank circuit also blocks the d-c voltage from the rotor of tuning capacitor C1. The output of the crystal oscillator is capacity coupled to the multiplier stage through capacitor C10. Grid resistor R1 provides the bias while capacitor C8 provides feedback from the plate tank circuit to the grid circuit. Capacitor C5 acts as a bypass to ground for the higher radio frequencies while the lower crystal frequency feed-back voltage is applied to the crystal. Capacitor C6 is cathode bypass to ground for radio frequency and choke L6 keeps radio frequency from the power supply. Jack J1 provides metering of the oscillator current for adjustment or test.

b. Multiplier Circuit. Tube V2 functions as a frequency multiplier. The output of the oscillator circuit is multiplied three times in this stage for a total frequency multiplication of six times the original crystal frequency. The output tank circuit of this stage consists of capacitor C2 and coil L2, which is tuned to the third harmonic of the oscillator output or the sixth harmonic of the crystal frequency, thus accomplishing the multiplying action. The plate voltage is shunt fed through coil L7 and the coupling to the circuit is through capacitor C14. The screen grid (pin 2) voltage is obtained from the voltage-divider circuit shown in figure 11. C11 and C12 are screen grid and cathode bypass capacitors respectively, and grid resistor R3 provides the bias.

c. R-f Amplifier Circuit. R-f amplifier tube V3 is operated as a class C amplitude-modulated amplifier. The plate and screen grid are modulated. The grid return circuit is through the multiplier stage tank circuit (consisting of capacitor C2 and coil L2), and grid resistor R4. The voltage drop caused by the grid current flow furnishes the grid bias. Resistor R4 is bypassed by capacitor C15. Jack J2 facilitates metering of the amplifier grid current for adjustment or test. Resistor R5 drops the screen-grid voltage to the proper value and capacitor C16 bypasses the r-f voltage to ground. Capacitor C17 is cathode bypass to ground. The amplifier tank circuit consisting of variable capacitors C3, C4, and coil L4 comprise an impedance matching network. The plate voltage is series fed through coil L8 and the tank circuit. Coils L3 and L5 form a link neutralizing circuit which feeds a small amount of out-of-phase voltage to the grid circuit. The neutralizing adjustment is controlled by the coupling of coil L5 to coil L4.

d. Antenna Circuit. The antenna is coupled to the amplifier through the impedance matching network. Variable capacitor C4 controls the *loading* (coupling), and variable capacitor C3 tunes the circuit to resonance at the operating frequency. Capacitor C18 provides a fixed minimum capacity across variable capacitor C4. Capacitor C19 serves as a blocking capacitor to isolate the d-c voltage from the antenna. The amplifier *loading* (antenna coupling) is controlled by the capacity ratio of C3 and C4 when the circuit is tuned to resonance. Relay K2 provides antenna change-over for use of the antenna on a receiver if required. Additional contacts on the relay are used to break the d-c voltage from the dynamotor and to provide *break-in* operation for a receiver if required.

53. MODULATOR AND POWER CIRCUITS (fig. 11).

Microphone transformer T1 couples the audio-frequency voltage developed by the microphone to the grids of modulator tubes V4 and V5. The d-c voltage for the microphone is obtained from the voltage drop across the resistor combination R10, R9, and R8. Resistor R11, with capacitors C21 and C22, comprises a decoupling network for the microphone circuit. Microphone jack J4 is located on the transmitter chassis and is used only for adjustment or test of the equipment. For normal operation, the microphone is connected to jack J9 on the remote control unit. The grid bias for modulator tubes V4 and V5 is obtained from the voltage-divider circuit consisting of resistors R8, R9, and R10. The secondary center tap of transformer T1 is connected to the bias terminal strip according to the transmitter power input ground polarity. For positive battery ground input, the bias lead is connected to the **red dot** terminal, and for negative battery ground input, the lead is connected to the **black**

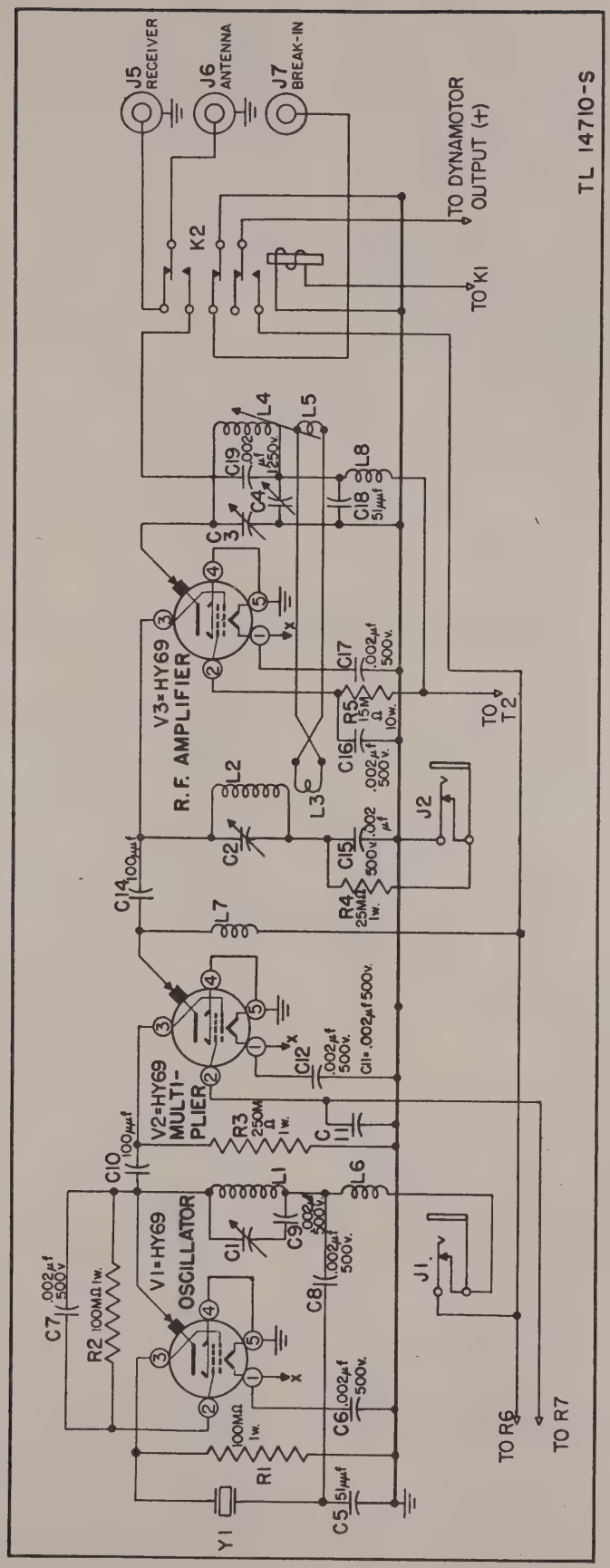


Figure 1o. Transmitter PTS-22X, radio-frequency section.

dot terminal. This is necessary in order to maintain proper grid bias for either positive or negative input. The screen-grid voltage for the modulator tubes is obtained from the voltage-divider circuit consisting of resistors R6 and R-7. The screen-grid circuit is bypassed for audio frequencies by capacitor C13. The plate voltage for the modulator tubes is fed through the primary winding center tap of modulation transformer T2. The d-c voltage for the r-f amplifier is fed through circuit metering jack J3, and the secondary winding of transformer T2. The audio-output voltage (modulation voltage) in the secondary winding of transformer T2 is superimposed on the d-c plate voltage for the r-f amplifier to produce amplitude modulation of the carrier.

54. POWER AND CONTROL CIRCUIT (fig. 11).

The d-c plate circuit power is developed by the dynamotor unit. Capacitor C20 bypasses the ripple component. Overload protection is provided by fuse F1 in the negative return circuit. Complete control of the equipment operation is through the *push-to-talk* button switch on the microphone. No power OFF-ON control switch is required. For normal operation of the equipment, the microphone is plugged into jack J9 on the remote control unit. For adjustment or test, jack J4 on the chassis is used to control the equipment. Operation of the microphone button switch operates relay K1, which in turn operates relay K2 and also simultaneously applies filament power and starts the dynamotor. Lamp I1 on the remote control unit indicates transmitter ON condition. Operation of the equipment is practically instantaneous, only about 1 second being required for full carrier output.

SECTION XI. TROUBLE SHOOTING

55. GENERAL TROUBLE-SHOOTING INFORMATION.

No matter how well equipment is designed and manufactured, faults occur in service. When such faults occur, the repairman must locate and correct them as rapidly as possible. This section contains general information to aid personnel engaged in the important duty of trouble-shooting.

a. Trouble-shooting Data. Take advantage of the material supplied in this manual to help in the rapid location of faults. Consult the following trouble-shooting data when necessary.

(*1*) Block diagram (fig. 9).

(*2*) Schematic diagram (fig. 13).

(*3*) Simplified and partial schematic diagrams (figures 10 and 11). These diagrams are particularly useful in trouble-shooting, because the repairman can follow the electrical functioning of the circuits more easily than on the regular schematics, thus speeding trouble location.

(*4*) Voltage and resistance data for all socket connections (fig. 12).

(*5*) Illustrations of components. Top and bottom views, which aid in locating and identifying parts (figs. 14 and 15).

(*6*) Pin connections. Pin connections on sockets, plugs, and receptacles are numbered or lettered on the various diagrams. Seen from the bottom, pin connections are numbered in a clockwise direction around the sockets.

b. Trouble-shooting Steps. The first step in servicing a defective radio set is to sectionalize the fault. Sectionalization means tracing the fault to the component or circuit responsible for the abnormal operation of the set. The second step is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal condition. Some faults such as burned-out resistors, r-f arcing, and shorted transformers can be located by sight, smell, and hearing. The majority of faults, however, must be located by checking voltage and resistance.

c. Localization. Paragraphs 57c to 57h describe the method of localizing faults within the individual components. These paragraphs are accompanied by trouble-shooting charts which list abnormal symptoms and their probable causes. The charts also give the procedure for determining which of the probable locations of the fault is the exact one. In addition, figure 12 shows the resistance and voltage at every socket pin connection.

d. Voltage Measurements. Voltage measurements are an almost indispensable aid to the repairman, because most troubles either result from abnormal voltages or produce abnormal voltages. Voltage measurements are taken easily, because they are always made between two points in a circuit and the circuit need not be interrupted.

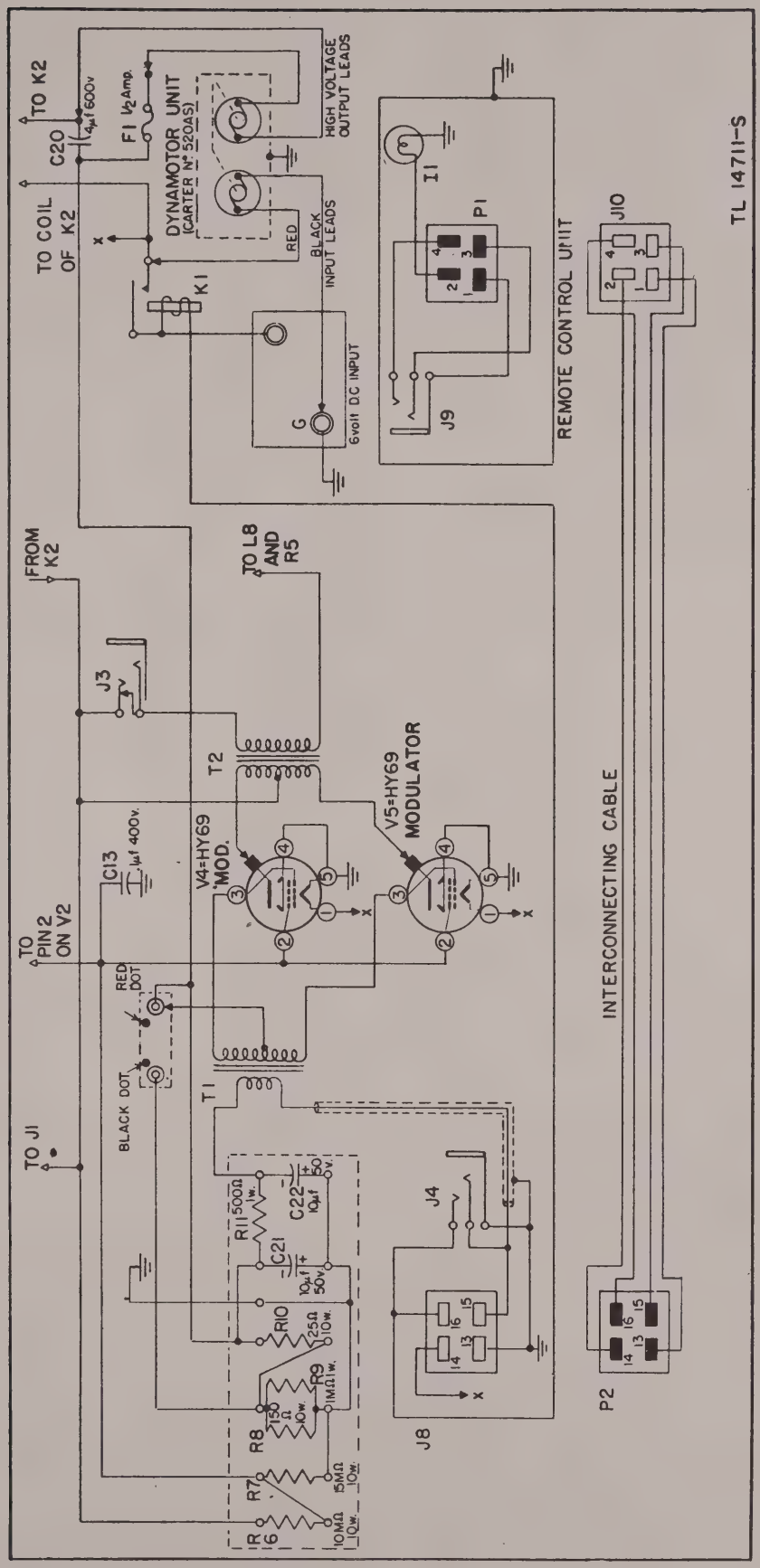


Figure 11. Transmitter PTS-22X, modulator and power circuits.

(*1*) Unless otherwise specified, the voltages listed on the voltage chart are measured between the indicated points and ground.

(*2*) Always begin by setting the voltmeter on the highest range so that the voltmeter will not be overloaded. Then, if it is necessary to obtain increased accuracy, set the voltmeter to a lower range.

e. Precautions Against High Voltage. Certain precautions must be followed when measuring voltages above a few hundred volts. High voltages are dangerous and can be fatal. When it is necessary to measure high voltages, observe the following rules:

(*1*) Connect the ground lead to the voltmeter.

(*2*) Place one hand in your pocket. This will eliminate the possibility of making accidental contact with either ground or another part of the circuit, thus causing the electricity to travel from one hand to the other.

(*3*) If the voltage is less than 300 volts, connect the test lead to the hot terminal (which may be either positive or negative with respect to ground).

(*4*) If the voltage is greater than 300 volts, shut off the power, connect the hot lead, step away from the voltmeter, turn on the power, and note the reading on the voltmeter. Do not touch any part of the voltmeter, particularly when it is necessary to measure the voltage between two points which are above ground.

f. Voltmeter Loading. It is essential that the voltmeter resistance be at least 10 times as large as the resistance of the circuit across which the voltage is measured. If the voltmeter resistance is comparable to the circuit resistance, the voltmeter will indicate a voltage lower than the actual voltage present when the voltmeter is removed from the circuit.

(*1*) The resistance of the voltmeter on any range can always be calculated by the following simple rule: Resistance of the voltmeter equals the ohms per volt multiplied by the full-scale range in volts. For example: The resistance of a 1,000-ohm-per-volt meter on the 300-volt range is 300,000 ohms (R = 1,000 ohms per volt times 300 volts = 300,000 ohms).

(*2*) To minimize the voltmeter loading in high-resistance circuits, use the highest voltmeter range. Although only a small deflection will be obtained (possibly only 5 divisions on a 100-division scale), the accuracy of the voltage measurement will be increased. The decreased loading of the voltmeter will more than compensate for the inaccuracy which results from reading only a small deflection on the scale of the voltmeter.

(*3*) When a voltmeter is loading a circuit, the effect can always be noted by comparing the voltage reading on two successive ranges. If the voltage readings on the two ranges do not agree, voltmeter loading is excessive. The reading (not the deflection) on the highest range will be greater than that on the lowest range. If the voltmeter is loading the circuit heavily, the deflection of the pointer will remain nearly the same when the voltmeter is shifted from one range to another.

(*4*) The ohm-per-volt sensitivity of the voltmeter used to obtain the readings recorded on the voltage and resistance charts in this manual is printed on each chart. Use a meter having the same ohm-per-volt sensitivity; otherwise it will be necessary to consider the effect of loading.

56. TEST EQUIPMENT.

In addition to the test instruments and tools required for alignment and adjustment, under section XIII, the following equipment is required:

a. Test Set. Test set I-56-( ) or equivalent will be required.

b. Dummy Load. The following types of dummy loads are recommended for testing of this equipment.

(*1*) A Mazda lamp bulb, 32 volt, 25 watt.

(*2*) Ohmite D-100-34, Signal Corps stock No. 3Z6003D4-1.

Either of the *dummy loads* recommended above may be used to simulate the antenna resistance for servicing or testing of the equipment. Connect the *dummy load* to a connector plug (same as used on coaxial cable ALC-22) Signal Corps stock No. 2Z3062-59.

57. TROUBLE-SHOOTING PROCEDURES.

a. Analyzing trouble in this equipment requires first the determination of the type of trouble or nature of the complaint. This can usually be determined from the operator's report or by an actual check test by the technical operator.

b. To analyze the trouble after determining the nature of the trouble requires a thorough knowledge of how the equipment operates, the function and adjustment of the various circuits, and the ability to recognize abnormal effects by inspection and operation of the set. Refer to sections X and XIII. Use a logical step-by-step process of elimination.

c. When the equipment becomes defective or in-

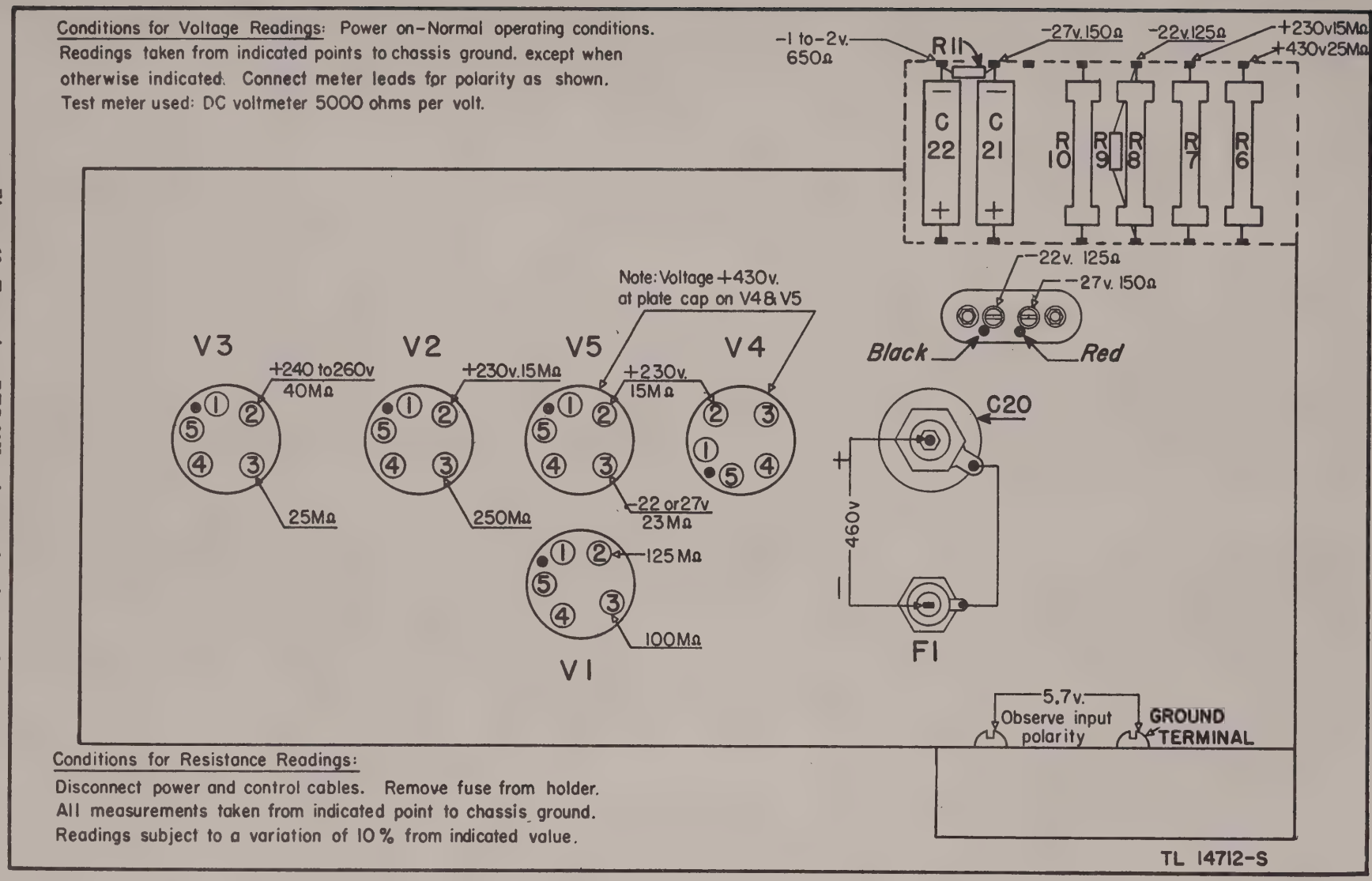


Figure 12. Transmitter PTS-22X, voltage and resistance chart.

operative, the trouble can quickly be isolated to either the remote control circuit or the transmitter unit. Connect the microphone to jack J4 (indicated MIC) on the transmitter chassis and disconnect the remote control cable plug P2 from J8. Check the operation from this location. If the set operates properly, the trouble is in the remote control cable or the remote control unit. If the trouble is still present, continue all trouble-shooting from this operating position. Make the following checks:

(1) Press the microphone button switch and note if the dynamotor starts and runs normal.

(2) Remove dust cover and inspect tubes; look for broken or loose tubes, loose or disconnected plate cap clips.

(3) Repeat test (1) and check to see if all tube filaments light. Replace any tube that does not light.

(4) Remove and inspect fuse. Replace a defective fuse and check operation of set. Remove and inspect the replacement fuse. If it is blown, a short circuit or defective component is the cause of the trouble.

(5) Under tests (1) and (3), if the dynamotor does not start and the tubes do not light, inspect the microphone unit and connector plug. Substitute another microphone if it is available.

d. If the above checks do not locate the trouble, it will be necessary to make an inspection of the under chassis components. Disconnect all cables and connectors. *Use care in handling the power input cables; always disconnect the hot lead from the battery before removing the input terminal cover.*

(1) Examine the wiring; look for broken or shorted connections.

(2) Examine for component parts which appear abnormal or defective, such as *bloated* capacitors, charred resistors, etc.

e. If examination of the wiring, chassis components, etc. do not reveal or localize the trouble, it will be necessary to use the test set and check the circuit diagrams (figs. 10, 11, and 13) and voltage-resistance chart (fig. 12). Check the resistance between the points indicated and ground as given on figure 12. In addition, check the resistance values of all resistor components, make a continuity test on all transformer and coil windings, and check each fixed capacitor for shorts or leakage. Resistor component values are given on the schematic diagram, figure 13.

NOTE: All resistor components have a ± 10 per cent tolerance. Therefore the actual measured value may differ from the indicated value by the allowable tolerance and still be satisfactory.

When measuring the resistance value of certain components, be careful not to get false readings because of other circuits or parts shunting the component being measured. This also applies to resistance measurements across capacitors, that is, a low value of resistance measured across a capacitor does not necessarily indicate a short or high leakage condition. When in doubt, disconnect the component from the circuit. Never replace a circuit component, particularly a resistor, until cause for failure has been determined and corrected.

f. To make the voltage measurements shown on figure 12 and also to check the equipment performance after a repair or service operation, the equipment must be set up and connected to a 6-volt storage battery. If necessary, these tests can be made with the set re-installed in the vehicle. For shop bench testing, use only a fully charged 6-volt battery and use heavy gauge input cables (size No. 1/0 gauge; if available, use two automotive type starter cables with clamps and lugs). Observe the input polarity for the battery connections.

g. With the equipment set up and adjusted for normal operating conditions, make the voltage measurements given on figure 12 and check the current values in the circuit metering jacks J1, J2, and J3 as given under section XIII for normal operation of the equipment. The use of this data and a logical circuit analysis usually discloses the source of trouble.

NOTE: In making voltage measurements and adjustments in the equipment, observe the precautions given in the safety notice and under paragraph 55f.

58. TROUBLE-SHOOTING CHART.

Symptom	Probable trouble	Corrections
1. Transmitter dead.	1. Defective microphone switch or plug. Defective remote control unit or cable.	Replace microphone. Check operation with microphone connected to J4.
	Blown fuse.	Replace fuse and check operation.
	Defective or burned-out tube.	Replace suspected tube.
	Broken or shorted antenna lead.	Examine antenna lead and connections.
	Defective crystal unit.	Replace with spare of same frequency.
2. Carrier with no modulation.	2. Defective microphone or plug.	Replace microphone.
	Broken microphone jack (J9) or defective control cable.	Check operation using jack J4.
	Open winding on T1 or T2.	Check continuity of windings.
3. Transmitter weak.	3. Dead or low battery.	Check and test vehicle battery.
	Weak tube.	Substitute new tube alternately in each socket and check operation.
	Broken antenna assembly.	Check antenna assembly.
	Transmitter out of adjustment.	Check adjustment (section XIII).
	Low dynamotor output voltage.	Check dynamotor brushes.

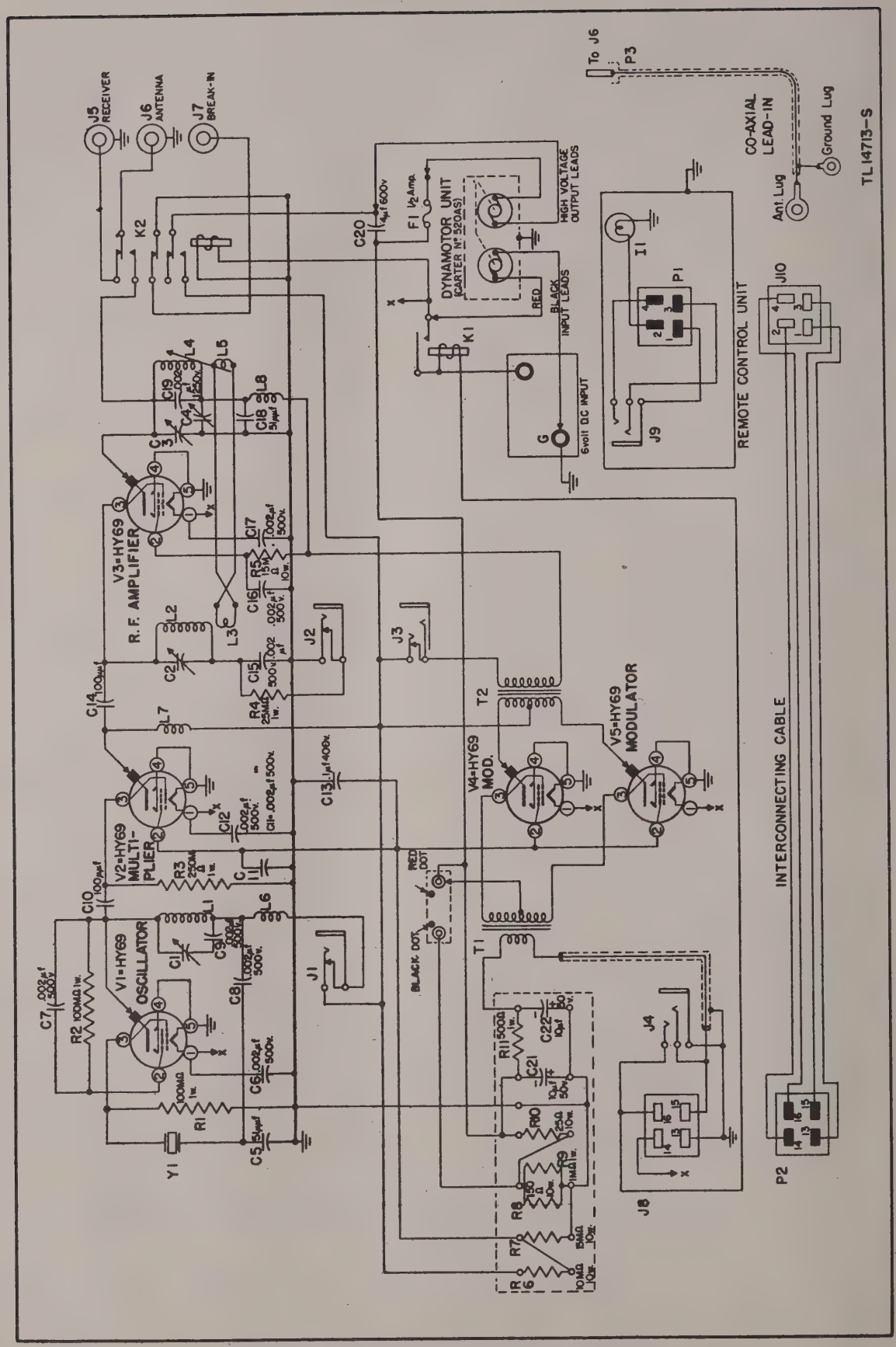


Figure 13. Transmitter PTS-22X, schematic diagram.

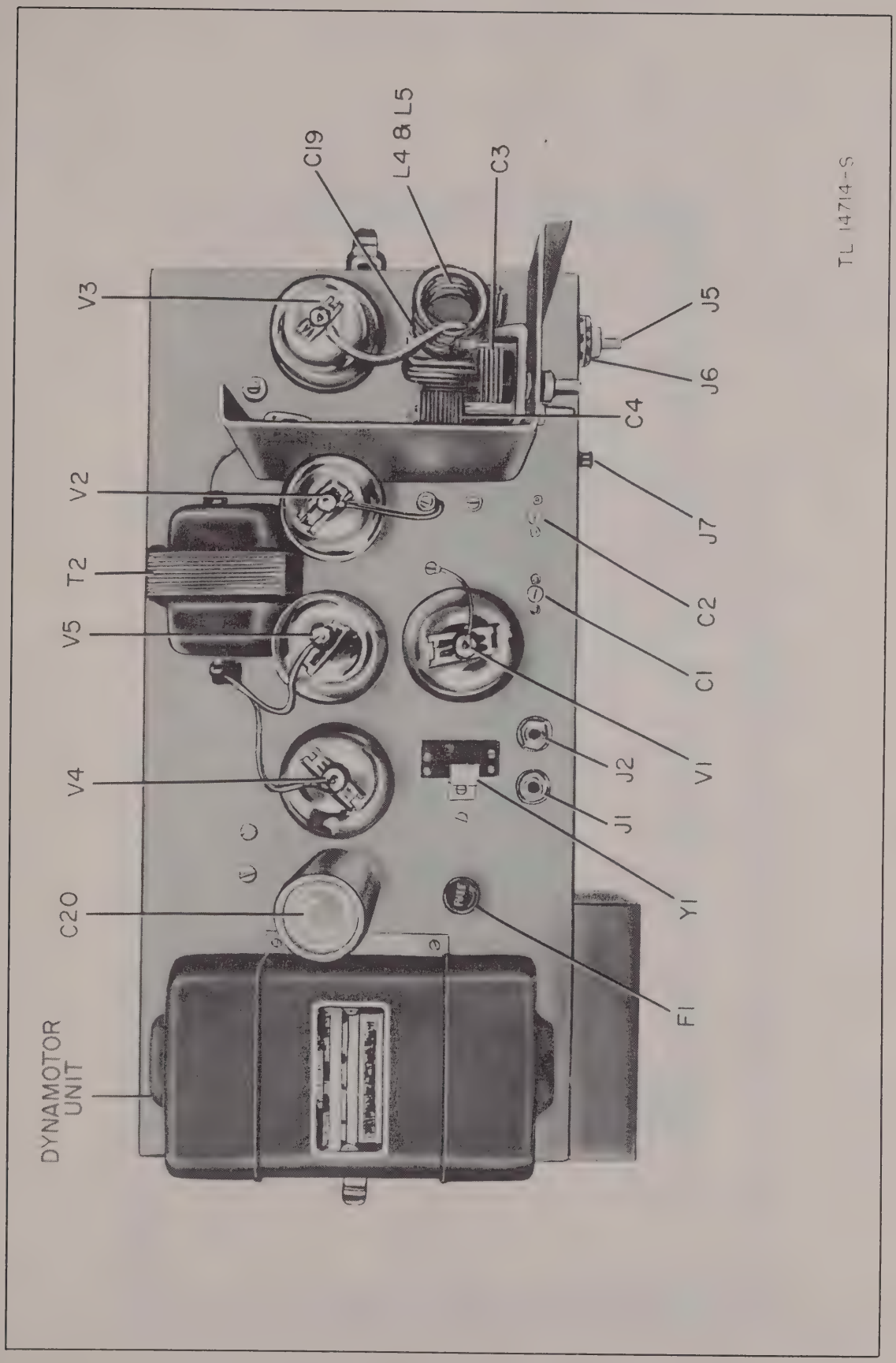


Figure 14. Transmitter PTS-22X, chassis, top view, parts location.

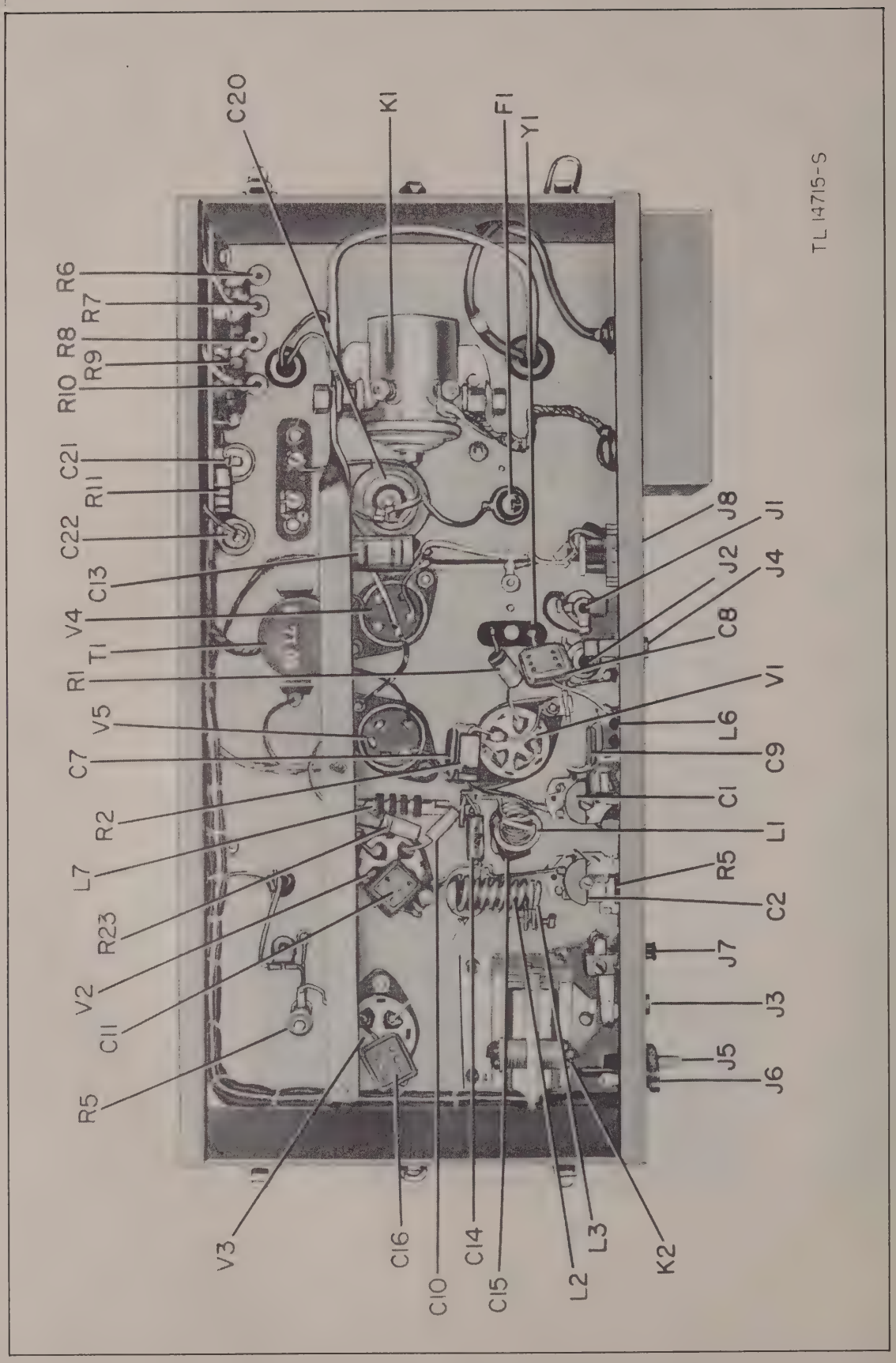


Figure 15. Transmitter PTS-22X, chassis, bottom view, parts location.

SECTION XII. REPAIRS

59. GENERAL.

Only component personnel supplied with adequate tools and instruments are authorized to service and repair this equipment. An inexperienced operator attempting to make repairs which should be made by a competent repairman may damage the equipment to such an extent that it has to be sent to a higher echelon for repair.

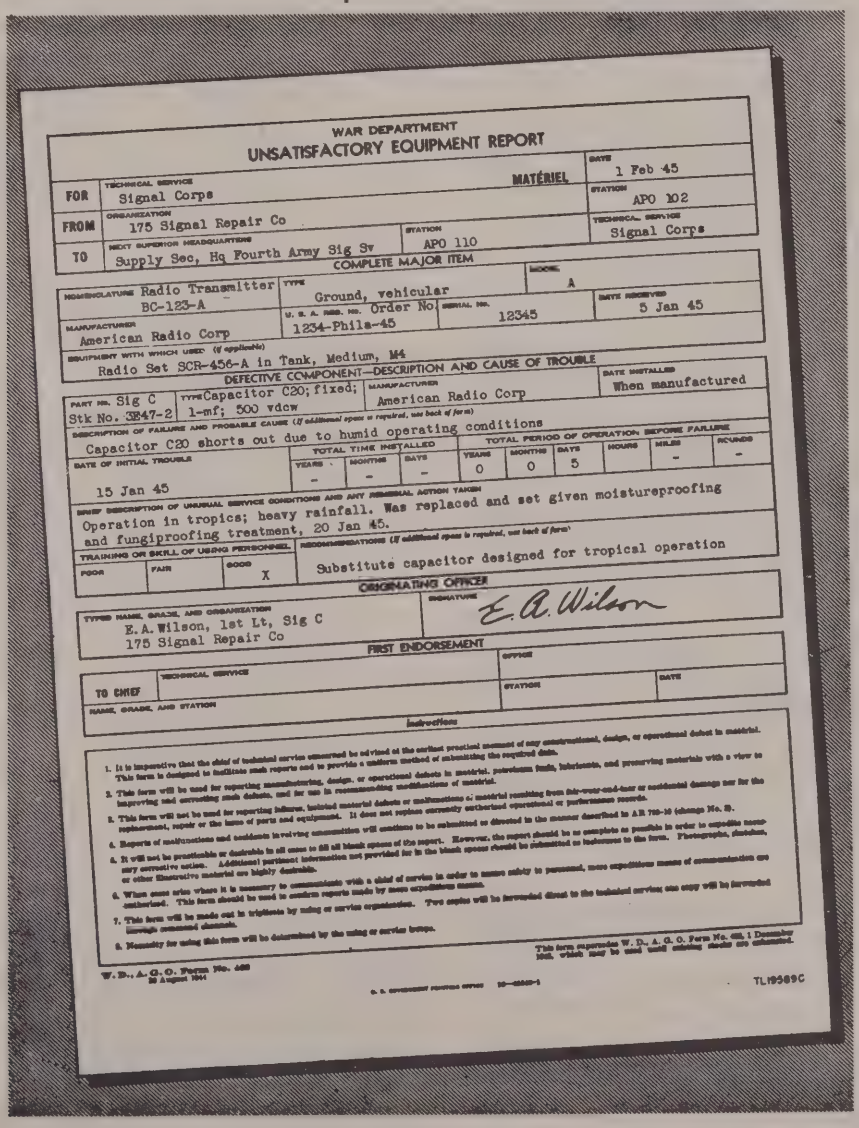
60. REPLACEMENT OF PARTS.

a. The construction of this equipment provides easy access to all parts and components. No special tools are required for the repair or replacement of any part.

b. Figures 14 and 15 show the location of the component parts with their reference symbols as indicated on the schematic diagrams.

c. When it is necessary to remove other circuit components to gain access to the defective part, make a record of the connections to the component removed and its location in the set. When necessary, indicate on the record, the color code of the leads with respect to the connections on the component removed. Before removing a part that appears to be defective, make a thorough electrical check.

d. When replacing components, make the lead lengths approximately the same as used for the



WAR DEPARTMENT
UNSATISFACTORY EQUIPMENT REPORT

FOR: TECHNICAL SERVICE: Signal Corps — MATÉRIEL — DATE: 1 Feb 45
FROM: ORGANIZATION: 175 Signal Repair Co — STATION: APO 110 — STATION: APO 102 — TECHNICAL SERVICE: Signal Corps
TO: NEXT SUPERIOR HEADQUARTERS: Supply Sec, Hq Fourth Army Sig Sv

COMPLETE MAJOR ITEM

NOMENCLATURE	TYPE	MODEL
Radio Transmitter BC-123-A	Ground, vehicular	A
MANUFACTURER: American Radio Corp	U. S. A. REG. NO. Order No 1234-Phila-45	SERIAL NO. 12345
DATE RECEIVED: 5 Jan 45		

EQUIPMENT WITH WHICH USED: Radio Set SCR-456-A in Tank, Medium, M4

DEFECTIVE COMPONENT—DESCRIPTION AND CAUSE OF TROUBLE

PART NO.	TYPE	MANUFACTURER	DATE INSTALLED
Sig C Stk No. 3847-2	Capacitor C20; fixed; 1-mf; 500 vdcw	American Radio Corp	When manufactured

DESCRIPTION OF FAILURE AND PROBABLE CAUSE: Capacitor C20 shorts out due to humid operating conditions

DATE OF INITIAL TROUBLE	TOTAL TIME INSTALLED YEARS	MONTHS	DAYS	TOTAL PERIOD OF OPERATION BEFORE FAILURE YEARS	MONTHS	DAYS	HOURS	MILES	ROUNDS
15 Jan 45	-	-	-	0	0	5		-	-

BRIEF DESCRIPTION OF UNUSUAL SERVICE CONDITIONS AND ANY REMEDIAL ACTION TAKEN: Operation in tropics; heavy rainfall. Was replaced and set given moistureproofing and fungiproofing treatment, 20 Jan 45.

TRAINING OR SKILL OF USING PERSONNEL: POOR — FAIR — GOOD: X

RECOMMENDATIONS: Substitute capacitor designed for tropical operation

ORIGINATING OFFICER

TYPED NAME, GRADE, AND ORGANIZATION: E. A. Wilson, 1st Lt, Sig C, 175 Signal Repair Co
SIGNATURE: E. A. Wilson

FIRST ENDORSEMENT

TO CHIEF — TECHNICAL SERVICE — OFFICE — STATION — DATE
NAME, GRADE, AND STATION

Instructions

1. It is imperative that the chief of technical service concerned be advised of the earliest practical moment of any constructional, design, or operational defect in material. This form is designed to facilitate such reports and to provide a uniform method of submitting the required data.
2. This form will be used for reporting manufacturing, design, or operational defects in material, petroleum fuels, lubricants, and preserving materials with a view to improving and correcting such defects, and for use in recommending modifications of material.
3. This form will not be used for reporting failures, isolated material defects or malfunctions of material resulting from fair-wear-and-tear or accidental damage nor for the replacement, repair or the issue of parts and equipment. It does not replace currently authorized operational or performance records.
4. Reports of malfunctions and accidents involving ammunition will continue to be submitted as directed in the manner described in AR 750-10 (change No. 2).
5. It will not be practicable or desirable in all cases to fill all blank spaces of the report. However, the report should be as complete as possible in order to expedite necessary corrective action. Additional pertinent information not provided for in the blank spaces should be submitted as inclosures to the form. Photographs, sketches, or other illustrative material are highly desirable.
6. When cases arise where it is necessary to communicate with a chief of service in order to assure safety to personnel, more expeditious means of communication are authorized. This form should be used to confirm reports made by more expeditious means.
7. This form will be made out in triplicate by using or service organizations. Two copies will be forwarded direct to the technical service; one copy will be forwarded through command channels.
8. Necessity for using this form will be determined by the using or service troops.

W. D., A. G. O. Form No. 468
20 August 1944

This form supersedes W. D., A. G. O. Form No. 468, 1 December 1941, which may be used until existing stocks are exhausted.

TL19589C

Figure 16. W.D., A.G.O. Form No. 468, Unsatisfactory Equipment Report, sample form.

original part. Remove any excess solder from tie-points or terminal lugs before installing the replacement component. Avoid using more solder than necessary to make a secure connection. The slightest amount of solder dropped accidentally inside the set can cause short circuits. Be very careful when soldering. Do not heat lugs or connections more than is absolutely necessary. Excessive heating may damage near-by chokes, capacitors, coils, and circuit wiring.

e. When replacing a component that is assembled or mounted on the chassis with machine screws and nuts, always replace the lockwashers. Secure the screws and nuts snugly, but do not overtighten them.

61. UNSATISFACTORY EQUIPMENT REPORT (fig. 16).

a. When trouble in equipment used by Army Ground Forces or Army Service Forces occurs more often than repair personnel feel it normal, War Department Unsatisfactory Equipment Report, W.D., A.G.O. Form No. 468 should be filled out and forwarded through channels to the Office of the Chief Signal Officer, Washington 25, D. C.

b. When trouble in equipment used by Army Air Forces occurs more often than repair personnel feel is normal, Army Air Forces Form No. 54 should be filled out and forwarded through channels.

SECTION XIII. ALIGNMENT AND ADJUSTMENT

62. GENERAL.

The transmitter is normally supplied with the proper crystal for the desired operating frequency and with the oscillator, multiplier, and amplifier tuning controls (C1, C2 and C3) pre-adjusted to this frequency. Following the installation as given in paragraphs 8, 9, 10, and 11, the tuning controls are checked for proper adjustment and the amplifier output network is adjusted to the antenna. This procedure is given under paragraphs 64 and 65. For conditions under which no operating frequency is assigned or the crystal is not included with the equipment, the pre-adjustment procedure is given under paragraph 66. The instructions given under paragraph 66 are also applicable to the readjustment procedure for a new operating frequency.

63. TEST INSTRUMENTS AND TOOLS REQUIRED.

The following test meters and tools are required for adjustment of the equipment:

a. Test meters.

1 direct-current milliammeter, scale range 0-10.

1 direct-current milliammeter, scale range 0-100 or more.

Connect the test meters to a two circuit plug (PL 55) as follows: positive meter terminal to the tip contact; negative meter terminal to the sleeve contact.

b. Tools.

For adjustment of the tuning controls the following are required:

1 alignment tool, consisting of an insulated (bakelite) rod with an 1/8-inch blade or a hexagon socket, size 1/4 inch.

1 screw driver (medium), blade width 1/4 inch.

1 socket wrench (spintite), size 1/2 inch.

1 two-circuit Plug PL-55 or a piece of 1/4-inch diameter bakelite or fibre rod 1 to 1-1/2 inches long (dummy plug).

64. INITIAL ADJUSTMENT.

The initial adjustment consists of checking the adjustment of the oscillator, multiplier, and amplifier tuning controls prior to making the final adjustment to the antenna.

a. The tuning controls are designated according to their functions as follows:

(*1*) Oscillator tuning control, capacitor C1, indicated OSC.

(*2*) Multiplier tuning control, capacitor C2, indicated MULT.

(*3*) Amplifier tuning control, capacitor C3, indicated AMP.

(*4*) Loading control, capacitor C4, indicated LOAD.

b. Reference marks to indicate the settings of variable capacitors of C1 and C2 are provided. Alignment of the capacitor rotor marks to the fixed marks on the chassis corresponds to the maximum capacity setting. For proper adjustment of the OSC and MULT controls (C1 and C2), the positions of the rotor marks should correspond, that is,

approximately the same capacity value is required for each capacitor.

c. To protect amplifier tube V3 from overloading during the initial adjustment, the plate and screen voltage must be disconnected. The dummy plug, either the 1/4-inch diameter rod or plug PL-55, is used for this purpose and is inserted in jack J3.

d. Proper adjustment of the OSC and MULT controls is determined by adjusting for the maximum or peak value of amplifier grid current as read on the test meter in jack J2.

CAUTION: In adjusting the transmitter, do not touch the coils, capacitors, tubes or other parts with the fingers. Make certain that the set is OFF before touching any component.

e. The adjustment procedure is as follows:

(*1*) Remove the cover from the chassis. Plug the microphone into jack J4 (MIC), test meter (scale range 0-10) into jack J2, and the dummy plug into jack J3.

(*2*) Press the microphone button switch and with the alignment tool adjust the OSC and MULT controls for maximum or peak reading on the test meter. The peak reading should be approximately 4 to 6 ma.

(*3*) Remove the dummy plug from jack J3 and plug in the test meter (scale range 0-100). Loosen the locknuts on the AMP and LOAD controls. Set the LOAD control to maximum capacity. Disconnect coaxial cable ALC-22 from J6.

(*4*) Press the microphone button switch and rapidly adjust the AMP control for the minimum or dip reading on the test meter. The minimum or dip meter reading indicates no-load amplifier tank circuit resonance. The test meter reading should be approximately 30 to 35 ma.

65. FINAL ADJUSTMENT.

The following outlines the procedure for adjusting the transmitter to the antenna.

a. The amplifier output network consists of coil L4, AMP control (C3), and LOAD control (C4). The degree of *loading* is indicated by the rise in amplifier plate current above the no-load resonance value, and is determined by the combined adjustment of the AMP and LOAD controls. With the LOAD control set to maximum capacity, the loading will be minimum. As the capacity of the LOAD control is decreased, the amplifier loading will increase. For each capacity change of the LOAD control, the amplifier circuit is re-tuned to resonance by adjusting the AMP control for minimum amplifier plate current. Maximum power output is entirely dependent upon proper adjustment of these controls.

b. When tuning the transmitter, it is desirable that the vehicle motor be idling with sufficient speed so that the generator is charging normally. The initial adjustment may be made with the motor shut off, but it is essential that the value of battery voltage be normal for the final loading adjustment to the antenna. In mobile installations, where the equipment is installed in the the trunk compartment, the final adjustment must be made with the compartment cover in the lowered position, that is, as nearly closed as possible.

c. Connect coaxial cable ALC-22 to jack J6. Plug the test meter (scale range 0-100) into jack J3, and set the LOAD control to maximum capacity. The procedure for adjustment to the antenna is as follows:

(*1*) Press the microphone button switch and adjust the AMP control for the minimum or dip reading on the test meter. The test meter reading will now be higher than the original no-load value.

(*2*) Decrease the capacity of the LOAD control in small increments, and re-adjust the AMP control for minimum or dip meter reading. Continue this procedure until the minimum meter reading reaches a value of 80 to 85 milliamperes (ma). DO NOT EXCEED 85 ma.

(*3*) Plug the test meter (range 0-10) into jack J2. Re-check the adjustment of the OSC and MULT controls by adjusting each for the maximum or peak meter reading. Under these conditions, the test meter reading will be slightly less than the value found under the initial adjustment, paragraph 64.

(*4*) Make a final adjustment of the AMP control for minimum test meter reading (test meter in jack J3) to assure circuit resonance. Tighten the locknuts on the LOAD and AMP controls. Remove the test meters and replace the cover. Plug the microphone into the jack on the remote control unit and check the equipment operation.

66. PRE-ADJUSTMENT PROCEDURE FOR A NEW OPERATING FREQUENCY.

a. When a new operating frequency is assigned or the crystal is not included with the equipment, the transmitter must be pre-adjusted before proceeding with the adjustments outlined under paragraphs 64 and 65.

b. The crystal frequency is determined by divid-

ing the operating frequency in kilocycles (kc) by the factor 6. For example, if the operating frequency is 36 mc or 36,000 kc, the crystal frequency will be 6,000 kc. Use this method of determining the crystal frequency when ordering or replacing crystals for the equipment.

c. Install the new crystal and replace the hold-down bracket. Plug the test meter (range 0-10) into jack J2, and the test meter (range 0-100) into jack J1. Insert the dummy plug into jack J3. Plug the microphone into jack J4. Disconnect coaxial cable ALC-22 from J6. Proceed to adjust the OSC and MULT controls as follows:

(*1*) Set the OSC and MULT controls for maximum capacity as indicated by alignment of the rotor shaft mark with the corresponding mark on the chassis.

(*2*) Press the microphone button switch and slowly rotate the OSC control in a counterclockwise direction until the test meter in jack J1 reads minimum current. For correct adjustment, the meter reading is 20 to 25 ma.

(*3*) Press the microphone button switch and slowly rotate the MULT control counterclockwise until the test meter reading in jack J2 reads maximum or peak current. The correct reading is 4 to 6 ma. For proper adjustment, the MULT control capacity setting should be approximately the same as that required for the OSC control, that is, the reference marks on the rotor shafts should be in the same relative positions with respect to the fixed marks on the chassis.

d. Before adjusting the amplifier circuit, it may be necessary to adjust the inductance of coil L4. The required inductance for the operating frequency can be obtained by increasing or decreasing the length of the coil. For maximum inductance, the coil length is shortened, that is, the coil turns are closer spaced. For operating frequencies between 35 to 40 mc (35,000 to 40,000 kc) the coil length should be approximately 2 inches. For operating frequencies lower than 35 mc, the inductance must be increased by *squeezing* the turns closer together. Compress the coil from the top end down. Do not change the position of the bottom turn with respect to the small coil L5. Final adjustment of the coil inductance is determined by adjustment of the amplifier circuit to the operating frequency. The procedure for adjusting the amplifier circuit is as follows:

(*1*) Remove the test meter from jack J1 and the dummy plug from jack J3. Plug the test meter (scale range 0-100) into jack J3. Set the LOAD control C4 in the maximum capacity position.

(*2*) Press the microphone button switch and rapidly adjust the AMP control for no-load circuit resonance as indicated by the minimum or dip test meter reading in jack J3. Note the no-load resonance setting of the AMP control, that is, the setting of the rotor plates with respect to the stator plates. For proper L/C ratio, the rotor plates should be meshed approximately 25 per cent or less of full capacity. If more than 25 per cent of the total capacity is required for no-load circuit resonance, increase the coil inductance by squeezing the turns closer together.

(*3*) Readjust the AMP control for circuit resonance and check the capacity setting of the control. If necessary, change the coil inductance and repeat the adjustment. For exact circuit resonance, the test meter reading should be 30 to 35 ma.

e. The neutralizing circuit is pre-set at the factory, and normally will not require adjustment for changes in operating frequency. To check the neutralizing circuit, the procedure is as follows:

(*1*) Adjust the amplifier circuit to resonance as given above.

(*2*) Insert the dummy plug in jack J3.

(*3*) Press the microphone button switch and adjust the AMP control to each side of the no-load resonance setting, and at the same time note the test meter reading in jack J2. If the meter reading *flicks* or changes as the resonance setting point is passed, the neutralizing circuit requires adjustment. To adjust the neutralizing circuit, it is necessary to change the coupling between coil L5 and the amplifier coil L4.

(*4*) Coil L5 is supported on a tie-point and by loosening the hexagon locknut, the coil can be rotated with respect to L4.

(*5*) To neutralize the amplifier, adjust the coupling between coils L4 and L5 until no change in the test meter reading in jack J2 can be detected as the AMP control is rotated through the no-load resonance point. Lock coil L5 securely in position.

f. An alternate method of neutralizing the amplifier is as follows:

(*1*) Adjust the amplifier circuit to exact no-load resonance as given above, that is, minimum test meter reading in jack J3.

(*2*) Alternately increase and decrease the capacity of the AMP control and note the test meter reading in jack J2. If the meter reading rises above

the no-load resonance value, and then decreases as the AMP control capacity is decreased, the coupling between coils L4 and L5 must be increased. Conversely, if the rise in meter reading occurs as the AMP control capacity is increased, the coupling must be decreased. When the coupling between coils L4 and L5 is correct, that is, the amplifier is properly neutralized, the meter reading will decrease from the no-load resonance peak value as the AMP control capacity is increased or decreased.

APPENDIX

SECTION XIV. REFERENCES

NOTE: For availability of items listed, check FM 21-6 and ASF Catalog SIG 2. Also see FM 21-6 for applicable technical bulletins, supply bulletins, modification work orders, and Changes.

67. ARMY REGULATIONS.

AR 380-5 Safeguarding Military Information.

68. SUPPLY PUBLICATIONS.

SIG 1 Introduction to ASF Signal Supply Catalog.

SIG 3 List of Items for Troop Issue.

SIG 4-1 Allowances of Expendable Supplies.

SIG 4-2 Allowances of Expendable Supplies for Schools, Training Centers, and Boards.

SIG 5 Stock List of All Items.

SIG 10 Fixed Plant Maintenance Lists.

SB 11-10 Signal Corps Kit and Materials for Moisture- and Fungi-Resistant Treatment.

SB 11-17 Electron Tube Supply Data.

69. TECHNICAL MANUALS ON AUXILIARY EQUIPMENT AND TEST EQUIPMENT.

TM 11-300 Frequency Meter Sets SCR-211-( ).

TM 11-303 Test Sets I-56-C, -D, -H, and -J.

TM 11-307 Signal Generators I-72-( ).

TM 11-321 Test Set I-56-E.

TM 11-472 Repair and Calibration of Electrical Measuring Instruments.

TM 11-2613 Voltohmmeter I-166.

TM 11-2626 Test Unit I-176.

TM 11-2627 Tube Tester I-177.

70. PAINTING, PRESERVING, AND LUBRICATION.

TB SIG 13 Moistureproofing and Fungiproofing Signal Corps Equipment.

71. CAMOUFLAGE.

FM 5-20 Camouflage, Basic Principles.

72. SHIPPING INSTRUCTIONS.

U. S. Army Spec. No. 100-14A Army-Navy General Specification for Packaging and Packing for Overseas Shipment.

73. DECONTAMINATION.

TM 3-220 Decontamination.

74. DEMOLITION.

FM 5-25 Explosives and Demolitions.

75. OTHER PUBLICATIONS.

FM 24-18 Radio Communication.

TB SIG 25 Preventive Maintenance of Power Cords.

TB SIG 66 Winter Maintenance of Ground Signal Equipment.

TB SIG 72 Tropical Maintenance of Ground Signal Equipment.

TB SIG 75 Desert Maintenance of Ground Signal Equipment.

TB SIG 123 Preventive Maintenance Practices for Ground Signal Equipment.

TB SIG 178 Preventive Maintenance Guide for Radio Communication Equipment.

TB 1-455 Electrical Fundamentals.

TM 11-310 Schematic Diagrams for Maintenance of Ground Radio Communications Sets.

TM 11-314 Antennas and Antenna Systems.

TM 11-430 Storage Batteries for Signal Communication.

TM 11-453 Shop Work.

TM 11-455 Radio Fundamentals.

TM 11-483 Suppression of Radio Noises.

TM 11-499	Radio Propagation Handbooks.
TB 11-499-( )*	Basic Radio Propagation Predictions.
TM 11-866	Radio Receivers BC-779-B, BC-794-B, and BC-1004-C, and Power Supply Units RA-74-C, RA-84-B, and RA-94-A.
TM 11-867	Radio Receiver BC-787-B.
TM 11-874	Radio Set AN/GRR-2 (Hallicrafters Model SX-28-A).
TM 11-887	Radio Receiver (Kaar Type PRS-9X).
TM 11-4000	Trouble Shooting and Repair of Radio Equipment.
TM 37-250	Basic Maintenance Manual.

76. FORMS.

W.D., A.G.O. Form No. 468 (Unsatisfactory Equipment Report).

Army Air Force Form No. 54 (Unsatisfactory Report).

77. ABBREVIATIONS.

a-f	audio-frequency
a-m	amplitude-modulated
d-c	direct-current
JAN	Prefix designation for radio electron tube procured under joint Army-Navy Specification JAN-1A.
kc	kilocycle
mc	megacycle
ma	milliampere
r-f	radio-frequency
mmf or MMF	micromicrofarad
Mf or MF	microfarad
r	ohm
M	1,000

78. GLOSSARY.

Refer to the glossary in TM 11-455.

* A new TB in this series is issued monthly which gives propagation predictions 3 months in advance.

SECTION XV. MAINTENANCE PARTS

79. MAINTENANCE PARTS FOR RADIO TRANSMITTER (KAAR TYPE PTS-22X).

The following information was compiled on 14 November 1945. The appropriate pamphlet of the ASF Signal Supply Catalog for radio transmitter (Kaar type PTS-22X) is:

Fixed plant maintenance list

SIG 10-141, Radio Transmitter PTS-22X

For the index of available catalog pamphlets, see the latest issue of ASF Signal Supply Catalog SIG 2.

80. MAINTENANCE PARTS FOR RADIO TRANSMITTER (KAAR TYPE PTS-22X)

Ref symbol	Signal Corps stock No.	Name of part and description	Mfr's part and code No.
	2C6729	RADIO TRANSMITTER PTS-22X: 30-40 mc, 6 v dc, xtal controlled, fixed freq. includes:	
	2A295-44	ANTENNA, whip: 84" lg, one piece	AS-184 (P33)
C1, 2	3DK9050V-64	CAPACITOR, variable: air, 4-50 mmf, 14 plate	ASP-50G (A34)
C3	3D9050V-110	CAPACITOR, variable: air, 4-50 mmf, 11 plate	K-50 (K14)
C4	3D9140V-23	CAPACITOR, variable: air, 6-140 mmf, 29 plate	K140 (K14)
C5, 18	3D9051-19	CAPACITOR, ceramic: 0.000051 mf, 500 vdcw	N-750K51 (E3)
C6, 7, 8, 9, 11, 12, 15, 16, 17	3K3020222	CAPACITOR, mica: 0.002 mf, 500 vdcw; CM30B22J	1W5D2 (C15)
C10, 14	3D9100-65	CAPACITOR, ceramic: 0.0001 mf, 500 vdcw	N-750-L-100 (E3)
C13	3DA100-109.6	CAPACITOR, paper: 0.1 mf, 400 vdcw	DT-4-P1 (C15)
C19	3DA2-151	CAPACITOR, mica: 0.002 mf, 1250 vdcw	5-FM-22 (S8)
C20	3DB4-181	CAPACITOR, paper: 4 mf, 600 vdcw	6GA-400 (I8)
C21, 22	3DB10-105.1	CAPACITOR, electrolytic: 10 mf, 50 vdcw	BR-105 (C15)
L1	3C1084Z27-7	COIL, RF: osc; single winding, 18 turns	L1-22 (K14)
L2	3C1084Z27-6	COIL, RF: multiplier; single winding, 7 turns	L2-22 (K14)

80. MAINTENANCE PARTS FOR RADIO TRANSMITTER (KAAR TYPE PTS-22X) (contd.)

Ref symbol	Signal Corps stock No.	Name of part and description	Mfr's part and code No.
L3	3C1084Z27-10	COIL, RF: coupling, 1 turn	L3-22 (K14)
L4	3C1084Z27-8	COIL, RF: amplr, 7-1/2 turns	L4-22 (K14)
L5	3C1084Z27-9	COIL, RF: coupling, 2 turns	L5-22 (K14)
L6, 7, 8	3C368-3	COIL, RF: choke, 2.5 mh at 125 ma, 35 ohm, 4 pie	19-1996 (M11)
Y1	(order thru channels)	CRYSTAL UNIT	E (K14)
	3H1514-16	DYNAMOTOR UNIT: 6 v input, 500 v at 200 ma output	520AS (C52) (Modified)
	3H1505-4/B5	BRUSH SET: consists of 4 brushes, hv and lv	No. 556 and No. 2 (C52)
F1	3Z1946	FUSE, cartridge: 1/2 amp, 250 v type 3 AG	1/2 (B9)
	3Z3285-2	FUSE HOLDER: for above fuse	HKM (B9)
	3G1000-113	INSULATOR, stand-off: Conical, ceramic	600 (J4)
J1, 2	2Z5598-13	JACK, phone: 2-cond.	2A (U4)
J3	2Z5531.47	JACK, phone: 2-cond.	503B (U4)
J4, 9	2Z5533A	JACK, phone: 3-cond. (same as J9 in remote control unit)	2B (U4)
J7	2Z5573.7	JACK, banana: single ckt	78-1M (A13)
	NSNR	MICROPHONE, carbon: 2-1/2" diam, 50 ohm	F1 (W5) 4-C (K14)
	2Z7111.19	PLUG: single prong	71-1M (A13)
K1	2Z7585-142	RELAY, SPST: 6 v dc coil	70-108050 (R11)
K2	2Z7591-39	RELAY: ant changeover, DPDT, 6 v dc; 0.3 amp, 18 ohm	204-AM-2A (A28)

80. MAINTENANCE PARTS FOR RADIO TRANSMITTER (KAAR TYPE PTS-22X) (contd.)

Ref symbol	Signal Corps stock No.	Name of part and description	Mfr's part and code No.
K2	3C1999-20A	COIL: (for relay K2)	204-AM-2A (A28)
R1, 2	3RC30BF104K	RESISTOR, carbon: 100,000 ohm, 1 w	RC30BF-104K
R3	3RC30BF244J	RESISTOR, carbon: 240,000 ohm, 1 w	RC30BF-244J
R4	3RC30BF243J	RESISTOR, carbon: 24,000 ohm, 1 w	RC30BF-243J
R5, 7	3Z6615-148	RESISTOR, WW: 15,000 ohm, 10 w	10F (W3)
R6	3Z6610-259	RESISTOR, WW: 10,000 ohm, 10 w	10F (W3)
R8	3Z6015-80	RESISTOR, WW: 150 ohm, 10 w	10F (W3)
R9	3RC30BF102K	RESISTOR, carbon: 1000 ohm, 1 w	RC30BF-102K
R10	3Z6002E5-5	RESISTOR, WW: 25 ohm, 10 w	10F (W3)
R11	3RC30BF511J	RESISTOR, carbon: 510 ohm, 1 w	RC30BF-511J
J5, 6	2Z8671.30	SOCKET, female: single cont	S-101-D (J5)
J8	2Z8639-9	SOCKET, female: 4-cont	S-404-AB or S-2404 AB (J5)
	2Z8675.29	SOCKET, tube: 5-cont ceramic	S3305 (M4)
	2Z8675.12	SOCKET, tube: 5-cont bakelite	RS-5 (A13)
	2Z8672.31	SOCKET, xtal: 2 cont bakelite	33-2 (A13)
	2Z9413.25	TERMINAL STRIP, bakelite: 13-term	TS-22 (K14)
	2Z9402	TERMINAL BOARD: 2 screw term	1720 (C6)
	2Z9403.19	TERMINAL BOARD: 3-term	1530 (C6)
	3Z3915-22	TERMINAL BOARD: 2-term	1522 (C6)

80. MAINTENANCE PARTS FOR RADIO TRANSMITTER (KAAR TYPE PTS-22X) (contd.)

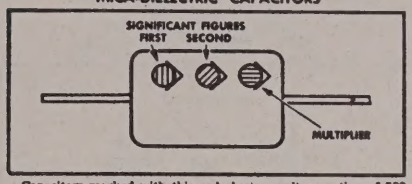
Ref Symbol	Signal Corps stock No.	Name of part and description	Mfr's part and code No.
T1	2Z9631.283	TRANSFORMER, AF: mic, pri 50 ohm, secd 115,000 ohm	K-7105 (P32)
T2	2Z9634.100	TRANSFORMER, AF: modulation, pri 10,000 ohm, secd 3500 ohm	512F (H16)
V1, 2, 3 4, 5	2JHY-69	TUBE JAN-HY-69	JANHY-69
	2Z9401.7	TERMINAL BOARD: 1-term	1514 (C6)
	NSNR	CABLE ASSEMBLY	ALC-22 (K14)
	1F4J2-3	CABLE, RF: coax, semirigid, surge impedance 34 ohm, one axial cond, No. 14 AWG solid	34-1000 (J4)
P3	2Z3062-59	PLUG, male: single prong	P-101D-1/4 (J5)
	NSNR	CABLE ASSEMBLY	CC-22 (K14)
	1B3020-4.4	CABLE, power, interconnecting, rubber jacketed, round shape 3/8" diam, 4 cond ea No. 20 AWG.	
P2	2Z7114.29	PLUG, male, 4-prong	P-404-FHT (J5)
J10	2Z8674.26	SOCKET, female, 4-cont	S-304-CCT (J5)
	NSNR	CABLE ASSEMBLY	
	1B3001-1.2	CABLE, power, interconnecting, round, No. 1/OAWG	PC-22 (K14)
		REMOTE CONTROL UNIT K-TR1	
J9	2Z5533A	JACK: (same as J4 in radio xmtr.)	2B (C4)
I1	2Z5952	LAMP, pilot: 6-8 v, 0.15 amp, miniature bayonet	47 (C3)
	2Z5991-4	LAMPHOLDER, pilot: miniature bayonet, red jewel	20 (D5)
P1	2Z3024-6	PLUG: 4-prong	P-304-AB (J5)

81. LIST OF MANUFACTURERS.

Code No.	*Name*
A 13	American Phenolic Corp.
A 28	Advance Electric Co.
A 34	American Steel Packages Co.
B 9	Bussman Mfg. Co.
C 6	Cinch Mfg. Corp.
C 15	Cornell-Dubilier Electric Corp.
C 52	Carter Motor Co.
D 5	Drake Mfg. Co.
E 3	Erie Resistor Co.
G 3	General Electric Co.
H 16	Hadley, Robert M., Co.
I 8	Industrial Condenser Corp.
J 4	Johnson, E. F., Co.
J 5	Jones, Howard B.
K 14	Kaar Engineering Co.
M 4	Millen, James, Mfg. Co.
M 11	Meissner Mfg. Co.
P 32	Peerless Electrical Products Co.
P 33	Premax (Chisholm-Ryder).
R 11	R. B. M. Mfg. Co.
S 8	Sprague Specialties Co.
U 4	Utah Radio Products Co.
W3	Ward-Leonard Electric Co.
W5	Western Electric Co.

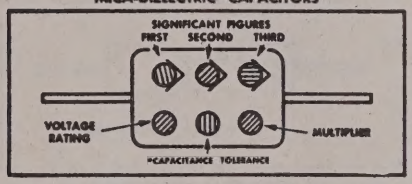
CAPACITOR COLOR CODES

RMA 3-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS

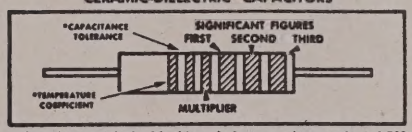


Capacitors marked with this code have a voltage rating of 500 volts.

RMA 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS



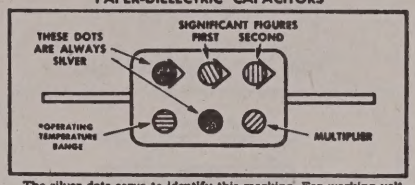
Capacitors marked with this code have a voltage rating of 500 volts.

RMA Radio Manufacturers Association JAN Joint Army-Navy

Note These color codes give all capacitances in micromicrofarads.

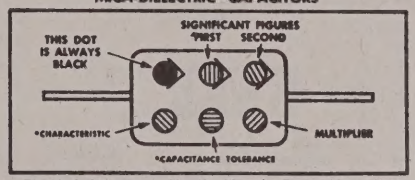
*Items marked with an asterisk are of interest primarily to depot and higher echelon repair personnel

JAN 6-DOT COLOR CODE FOR PAPER-DIELECTRIC CAPACITORS



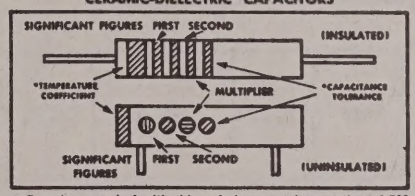
The silver dots serve to identify this marking. For working voltages see JAN type designation code.

JAN 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



The black dot serves to identify this code. For working voltages see JAN type designation code.

JAN COLOR CODE FOR FIXED CERAMIC-DIELECTRIC CAPACITORS



Capacitors marked with this code have a voltage rating of 500 volts. Either the band or dot code may be used.

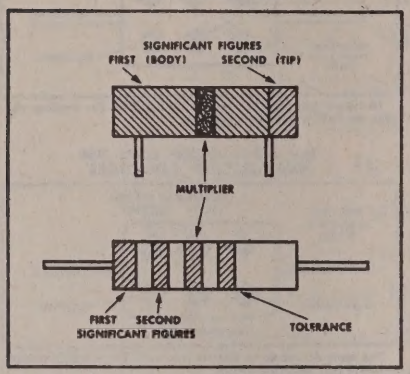
COLOR	SIGNIFICANT FIGURE	MULTIPLIER			RMA VOLTAGE RATING
		RMA MICA-AND CERAMIC-DIELECTRIC	JAN MICA-AND PAPER-DIELECTRIC	JAN CERAMIC-DIELECTRIC	
BLACK	0	1	1	1	
BROWN	1	10	10	10	100
RED	2	100	100	100	200
ORANGE	3	1,000	1,000	1,000	300
YELLOW	4	10,000			400
GREEN	5	100,000			500
BLUE	6	1,000,000			600
VIOLET	7	10,000,000			700
GRAY	8	100,000,000		0.01	800
WHITE	9	1,000,000,000		0.1	900
GOLD		0.1	0.1		1,000
SILVER		0.01	0.01		2,000
NO COLOR					500

TS 13497A

Figure 17. Capacitor color codes.

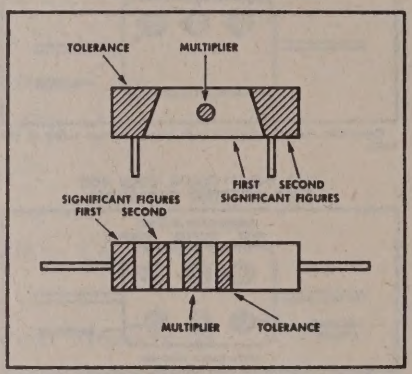
RESISTOR COLOR CODES

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS



Insulated fixed composition resistors with axial leads are designated by a natural tan background color. Non-insulated fixed composition resistors with axial leads are designated by a black background color.

JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS



Resistors with axial leads are insulated. Resistors with radial leads are uninsulated.

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	TOLERANCE (PERCENT)
BLACK	0	1	
BROWN	1	10	
RED	2	100	
ORANGE	3	1,000	
YELLOW	4	10,000	
GREEN	5	100,000	
BLUE	6	1,000,000	
VIOLET	7	10,000,000*	
GRAY	8	100,000,000*	
WHITE	9	1,000,000,000*	
GOLD		0.1*	5
SILVER		0.01*	10
NO COLOR			20

*JAN ONLY

Example: A 50,000-ohm resistor with a standard tolerance of 20 percent (no color) would be indicated by a green ring (5), a black ring (0), and an orange ring (000)

RMA: Radio Manufacturers Association
JAN: Joint Army-Navy

TI 13418 A

Figure 18. Resistor color codes.

U. S. GOVERNMENT PRINTING OFFICE : O—1950